BOILERS AND ACCESSORIES FOR STEAM PLANTS

- BOILERS
- SUPERHEATERS
- FURNACES
- MECHANICAL STOKERS
- CHIMNEYS
- WATER SOFTENERS
- FILTERS
- PIPING, VALVES
- STEAM SEPARATORS
- PUMPS
- CONVEYORS
- ELECTRIC CRANES
- ETC. ETC.

BABCOCK & WILCOX LTD.

Code Word: "AWKOPPER."

MARCH, 1912.

ACCESSORIES

SECTION I.

TYPES OF

BABCOCK & WILCOX BOILERS

AND

SUPERHEATERS.

BABCOCK & WILCOX LTD.

Head Offices:

ORIEL HOUSE, FARRINGDON STREET, LONDON, E.C.

Works: RENFREW, SCOTLAND.

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BABCOCK & WILCOX LIMITED.

Head Office:

ORIEL HOUSE, FARRINGDON STREET, LONDON, E.C.

Telegraphic Address for all Offices, "Babcock" (except New York, Oberhausen, Bombay, and Calcutta); for New York, "Gloveboxes"; for Oberhausen, "Babcockwerke"; for Bombay and Calcutta, "Boiler."

Head Office Telephone: No. 5540 (Holborn) 8 lines.

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BABCOCK & WILCOX BOILERS

AND

SUPERHEATERS.

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FRANCE: Fonderies et Ateliers de la Courneuve, Chaudières Babcock & Wilcox, 6 Rue Laferrière, PARIS.

GERMANY: Deutsche Babcock & Wilcox-Dampfkesselwerke-Act.-Ges., OBERHAUSEN.

WORKS - - RENFREW, SCOTLAND.

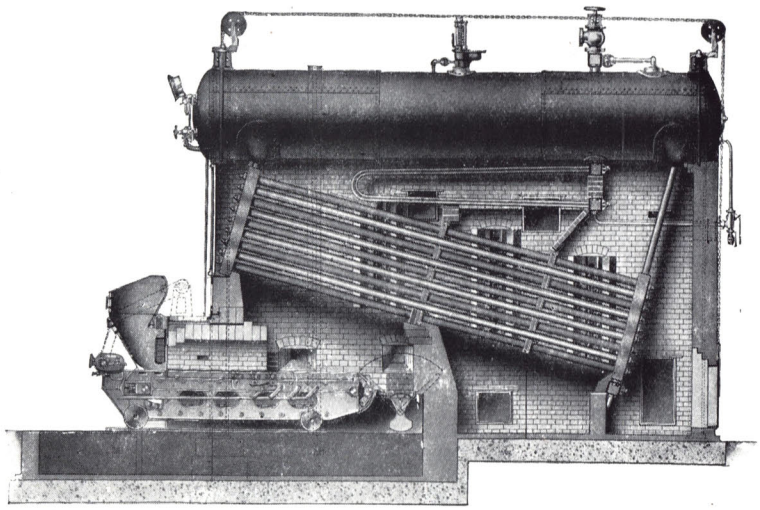
THE BABCOCK & WILCOX

PATENT WATER-TUBE BOILER.

SPECIALLY DESIGNED FOR THE

RAPID, ECONOMICAL, AND SAFE GENERATION OF STEAM

UP TO THE HIGHEST PRESSURES.



BABCOCK & WILCOX BOILER, FITTED WITH INTEGRAL SUPERHEATER AND MECHANICAL CHAIN GRATE STOKER.

(Side View, with part of Brickwork removed).

OVER **9,000,000** H.P. LAND TYPE

AND

2,250,000 H.P. MARINE TYPE BOILERS

IN USE THROUGHOUT THE WORLD.

SECTION I.

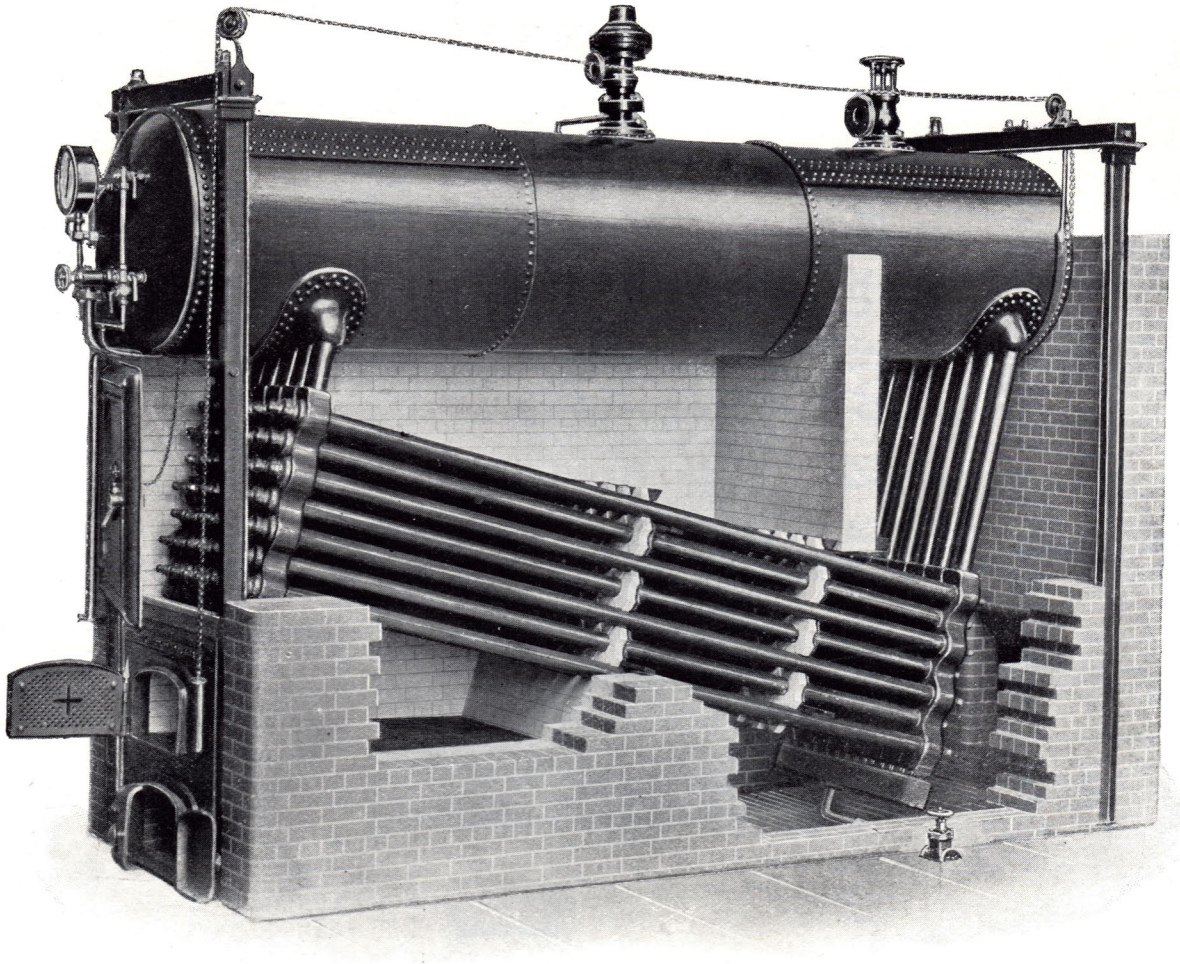
Types of Babcock & Wilcox Boilers and Superheaters.

BOILERS.

THERE are four types of Babcock & Wilcox Boilers in general use, all of them made on the same principle of construction and circulation of water. Compared with the ordinary types of boilers, each of these has similar points of advantage, which are fully described in our publication "Steam."

The type of boiler most generally used at home, in the United States of America, on the Continent of Europe, and also in the Colonies (where exceptional difficulties in transport do not exist), is that with the longitudinal steam and water drum. We call this construction the **"Class W.I.F."** (see illustration, page 10). Even this type, compared with the **ordinary shell boiler,** presents enormous advantages in the cost of freight and in facility for transport, it having only one heavy part—namely, the steam and water drum—which varies from about 12 cwt. in the smallest size up to about four tons in the larger sizes; thus the boiler is one which is easily carried wherever railways or good roads exist.

The second type we call the **"Class C.T." or Cross-type** (see illustration, page 18), and it has a short steam and water drum, placed cross-wise. **This is a type which is easily handled even under exceptionally difficult conditions of transport.** In this boiler also the steam and water drum is the heaviest part; but, even in the largest sizes, it is of such moderate



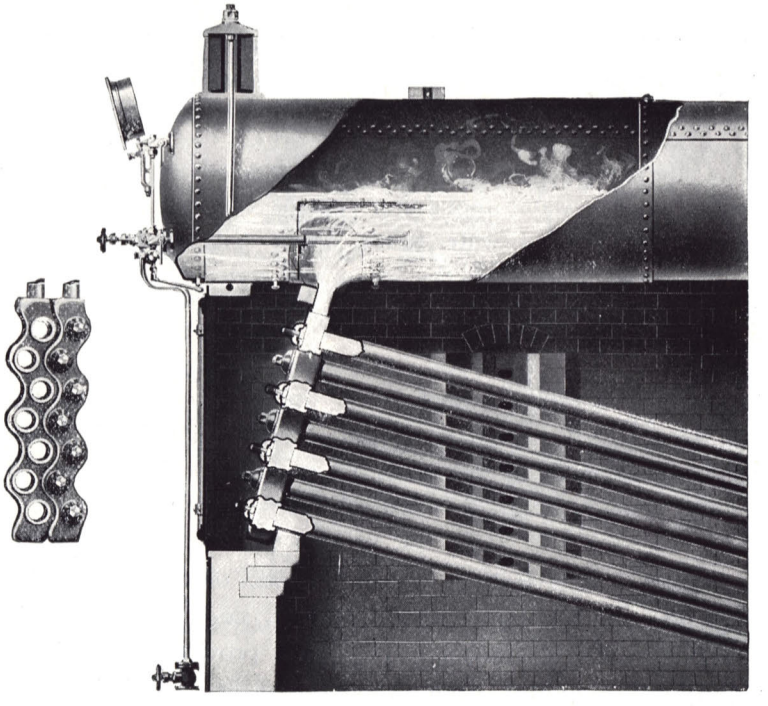
BABCOCK & WILCOX PATENT WATER-TUBE LAND BOILER. CLASS W.I.F.

weight that it can be carried in a cart over difficult roads. **Where it is necessary to construct a boiler suitable for transport by mule-back,** we use this type with the steam and water drum divided into sections, which are either bolted or riveted together at the place where the boiler is erected.

The third type is the **Portable boiler,** constructed to suit cases in which **not only is transport difficult,** but where **ordinary bricks or stone are not available** for encasing the furnace. As will be seen from the description and illustrations on pages 22 to 25, this is a cross-type boiler encased in ironwork, and provided with a lining of firebrick for the furnace. This boiler is complete with its own chimney, and a feed-pump and injector can be readily attached to the iron casing.

The fourth type is the **Marine boiler,** constructed for **use on board ship** (see illustration and description on pages 28 and 29). This type of boiler is also suitable for use on land, and is illustrated and described on pages 26 and 27.

All the above types can be made with furnaces suitable for burning either bituminous or anthracite coal, wood fuel—either as logs, shavings, or sawdust,—straw, coffee husk, rice husk, and bagasse; in fact practically any fuel can be used.



VIEW SHOWING ARRANGEMENT OF WATER-TUBES WITH THEIR CONNECTING HEADERS ATTACHED TO STEAM AND WATER DRUM.

The Babcock & Wilcox Patent Water-Tube Boiler,

SPECIALLY DESIGNED FOR THE

RAPID, ECONOMICAL, AND SAFE GENERATION OF STEAM

AT ANY PRESSURE UP TO THE HIGHEST PRACTICABLE.

General Description.—The principal elements in the construction of the Boiler consist of three essential parts, each connected with the others and each of which has a part in the process of steam-raising.

(1st) *A Series of inclined Water-Tubes* over the furnace, in which the water, being divided into small volumes, is quickly raised to a high temperature, and rises through a series of separate connecting boxes, or "headers," at the front end into

(2nd) *A Horizontal Steam and Water Drum*, where the steam separates from the water. The water remaining returns through the vertical tubes at the back into the inclined water-tubes, where it is subjected to the action of the fire and again passes into the steam and water drum ; *thus a continuous and rapid circulation in one direction is kept up and a uniform temperature maintained throughout the Boiler.*

(3rd) *A Mud Collector* attached to the *lowest* point of the inclined water-tubes, into which any matter held in suspension in the water is, to a large extent precipitated, by reason of its greater specific gravity, during the passage of the water through the vertical tubes and rear headers.

Construction.—The inclined water-tubes are of wrought steel, expanded at each end into sinuous boxes of steel, each connecting one zig-zag row of tubes. These end connecting boxes are provided with handholes for cleaning purposes opposite each water-tube—the handhole covers being *machined to form metal to metal joints*, thus dispensing with all perishable material as employed in ordinary joints. The covers are held in place by

wrought steel clamps. The end connecting boxes are attached to the horizontal steam and water drum by short tubes, expanded into accurately-bored holes, thus providing a large and continuous waterway through all the parts. The steam and water drum is made of the best selected mild steel, and is double riveted or butt strapped. The mud-collector is made of **wrought steel.**

Water Circulation.—All the water circulates in one direction, no cross currents obstructing it. The water, sweeping swiftly through the Boiler, scours the tubes, and prevents to a large extent incrustation or the accumulation of sediment, except in the mud-collector, whence it is readily blown out.

Safety.—All unequal strains are avoided by the construction of the Boiler; *all joints are removed from the immediate action of the fire*—the thinnest heating surface, and therefore the most efficacious for the purpose, being made to do the greatest duty; the rapid circulation gives uniform temperature; the parts subject to pressure are small in diameter and of a strength greatly in excess of any pressure likely to be brought to bear upon them.

Erection.—The entire boiler, with the exception of the furnace, is suspended on wrought iron girders and columns, thus enabling it to expand and contract without undue strain; this arrangement also allows access to the brickwork without disturbing the Boiler.

Economy.—The effective heating surfaces are thin, the volumes of water in contact with them are small, and receive the flames at right angles to their course. The tubes being zigzagged, thoroughly break up the gases as they rise, which, passing into the combustion chamber under the drum, expand and combine before again passing a second and third time through the tubes. *Complete Combustion, Rapid Steaming, and consequent economy are thus facilitated.*

Ease of Transportation.—The Boilers, being built in sections of moderate weight, are specially suitable for shipment or for erection where large weights are difficult to handle. See pages 9 and 11.

Cleaning and Repairs.—All parts are easy of access, internally and externally, and can be readily kept in the most perfect order; the renewal of every part is easy and does not require structural alterations.

Durability.—Many of these Boilers have been at work over twenty years without requiring repairs.

For particulars as to the various sizes of Boilers, see pages 14 and 15.

LIST OF STANDARD SIZES OF BABCOCK & WILCOX PATENT WATER-TUBE BOILERS. W.I.F. TYPE.

Heating Surface.		Evaporation per Hour.		† Code Word for 120 lbs. Pressure. The Fuel being		Construction.						Approx. Total Weight (Packed).		Space Occupied		
						Tubes.			Drum.					Single Boiler.		Two Boilers in Battery.
														Over Brickwork.		
Square Feet.	Square Metres.	Lbs.	Kilos.	Coal.	Wood.	Wide.	High.	Long.	No.	Dia.	Long.	Tons.	Kil.	Length.	Width.	Height when Hand-fired	Width.
119	11·07	360	165	Mugriento.	Mujeracho.	3	4	6	1	24	10′ 5″	3½	3,525	9′ 6″ ×	4′ 5″ ×	9′ 11⅛″	8′ 0″
150	14·15	460	210	Mujeriles.	Mujerona.	3	4	8	1	24	12′ 6″	4	4,080	11′ 6″ ×	4′ 5″ ×	9′ 11⅛″	8′ 0″
181	16·83	520	240	Mulacchia.	Muladares.	3	5	8	1	24	12′ 6″	4½	4,535	11′ 6″ ×	4′ 5″ ×	10′ 5⅛″	8′ 0″
219	20·37	660	300	Mulaterio.	Mulcebo.	3	5	10	1	24	14′ 9″	4¾	4,785	13′ 6″ ×	4′ 5″ ×	10′ 5⅛″	8′ 0″
293	27·25	890	405	Mulcemus.	Mulcenda.	4	5	10	1	30	15′ 0″	5½	5,545	13′ 6″ ×	5′ 0″ ×	10′ 11⅛″	9′ 2″
343	31·90	1,050	480	Mulctrum.	Mulesche.	4	5	12	1	30	17′ 0″	5¾	5,795	15′ 6″ ×	5′ 0″ ×	10′ 11⅛″	9′ 2″
401	37·29	1,200	555	Mulettino.	Mulgebat.	4	6	12	1	30	17′ 7″	6	6,045	16′ 0″ ×	5′ 8″ ×	12′ 5⅝″	9′ 10″
460	42·75	1,380	630	Mulgemur.	Mulgenda.	4	6	14	1	30	19′ 9″	6½	6,550	19′ 0″ ×	5′ 8″ ×	12′ 5⅝″	9′ 10″
526	48·92	1,600	735	Mulherigo.	Muliebrity.	4	7	14	1	30	19′ 9″	7	7,055	19′ 0″ ×	5′ 8″ ×	12′ 11⅝″	9′ 10″
593	55·15	1,800	825	Mulinava.	Mulinerete.	4	8	14	1	30	19′ 9″	7¼	7,305	19′ 0″ ×	5′ 8″ ×	13′ 5⅝″	9′ 10″
735	68·36	2,250	1,020	Multanda.	Multesimo.	5	8	14	1	36	19′ 10″	8½	8,655	19′ 0″ ×	6′ 3″ ×	13′ 11⅝″	11′ 0″
870	80·91	2,650	1,215	Multocular.	Multopere.	6	7	16	1	36	21′ 11″	10¼	10,230	21′ 0″ ×	6′ 10″ ×	13′ 5⅝″	12′ 2″
983	91·44	3,000	1,365	Mundicia.	Mundinovi.	6	8	16	1	36	21′ 11″	10¾	10,835	21′ 0″ ×	6′ 10″ ×	14′ 0⅞″	12′ 2″
1098	102·11	3,350	1,530	Mungimos.	Mungoado.	6	9	16	1	36	21′ 11″	11½	11,590	21′ 0″ ×	6′ 10″ ×	14′ 6⅞″	12′ 2″
1218	113·27	3,700	1,695	Muniarum.	Munifiche.	6	9	18	1	36	23′ 10″	12¼	12,345	23′ 0″ ×	6′ 10″ ×	15′ 0⅞″	12′ 2″
1265	117·76	3,850	1,755	Munitanda.	Munonera.	7	8	18	1	36	23′ 10″	13¼	13,355	23′ 0″ ×	7′ 5″ ×	14′ 6⅞″	13′ 4″
1411	131·22	4,300	1,965	Muraglione.	Muramento.	7	9	18	1	36	23′ 10″	14	14,110	23′ 0″ ×	7′ 5″ ×	15′ 0⅞″	13′ 4″
1426	132·62	4,350	1,980	Murcharas.	Murciana.	7	9	18	1	42	24′ 1″	14¼	14,360	23′ 0″ ×	7′ 5″ ×	15′ 7″	13′ 4″
1619	150·58	4,900	2,250	Murucuya.	Muschioso.	8	9	18	1	42	24′ 1″	14¾	14,865	23′ 0″ ×	8′ 0″ ×	15′ 7¾″	14′ 6″
*1741	161·91	5,300	2,430	Muserolle.	Musoliera.	12	7	16	2	36	21′ 11″	17¼	17,526	21′ 0″ ×	10′ 4″ ×	15′ 0⅝″	19′ 2″
1790	166·29	5,400	2,490	Terrontera.	Terrosidad.	8	10	18	1	42	24′ 1″	16¼	16,511	23′ 0″ ×	8′ 0″ ×	16′ 1¾″	14′ 6″
1827	169·91	5,600	2,550	Mustarius.	Mutabilis.	9	9	18	1	48	24′ 3″	17	17,273	23′ 0″ ×	8′ 7″ ×	16′ 1¾″	15′ 8″
*1966	182·84	6,000	2,730	Myagros.	Myopathy.	12	8	16	2	36	21′ 11″	19	19,305	21′ 0″ ×	10′ 4″ ×	15′ 6⅞″	19′ 2″
2010	186·72	6,100	2,790	Tersabamos.	Tersasteis.	9	10	18	1	48	24′ 3″	19¼	19,559	23′ 0″ ×	8′ 7″ ×	16′ 7¾″	15′ 8″
*2197	204·32	6,700	3,060	Tergisteis.	Teriacal.	12	9	16	2	36	21′ 11″	20¼	20,575	21′ 0″ ×	10′ 4″ ×	16′ 0⅝″	19′ 2″
2255	209·5	6,800	3,135	Trasandato.	Trasapeva.	10	10	18	1	54	24′ 5″	20¾	21,083	23′ 0″ ×	9′ 2″ ×	17′ 3⅛″	16′ 10″
*2437	226·64	7,400	3,390	Ternecita.	Ternericos.	12	9	18	2	36	23′ 10″	22	22,353	23′ 0″ ×	10′ 4″ ×	16′ 2⅝″	19′ 2″
*2531	235·38	7,700	3,525	Terneruela.	Ternilloso.	14	8	18	2	36	23′ 10″	24⅕	24,993	23′ 0″ ×	11′ 6″ ×	15′ 8⅛″	21′ 6″
*2690	250·00	8,200	3,750	Tertenant.	Tertulio.	12	10	18	2	36	23′ 10″	24¾	25,247	23′ 0″ ×	10′ 4″ ×	16′ 8⅛″	19′ 2″
*2823	262·54	8,600	3,930	Terragnolo.	Terregoso.	14	9	18	2	36	23′ 10″	25¼	25,655	23′ 0″ ×	11′ 6″ ×	16′ 2⅝″	21′ 6″
*2852	265·24	8,700	3,975	Terreplein.	Terrigena.	14	9	18	2	42	24′ 1″	25¾	26,163	23′ 0″ ×	11′ 6″ ×	16′ 8¼″	21′ 6″
*3140	292·00	9,600	4,380	Teruncius.	Terzavate.	14	10	18	2	42	24′ 1″	26¾	27,179	23′ 0″ ×	11′ 6″ ×	17′ 2¼″	21′ 6″
*3240	301·00	9,900	4,515	Tesaurero.	Tesbique.	16	9	18	2	42	24′ 1″	27¼	27,687	23′ 0″ ×	12′ 8″ ×	16′ 8¼″	23′ 10″
*3580	333·00	11,000	4,995	Tesoneria.	Tesserula.	16	10	18	2	42	24′ 1″	28½	28,957	23′ 0″ ×	12′ 8″ ×	17′ 2¼″	23′ 10″
*3654	340·00	11,200	5,100	Tessitrice.	Testacudo.	18	9	18	2	48	24′ 3″	32	32,513	23′ 0″ ×	13′ 10″ ×	17′ 2¾″	26′ 2″
*4020	374·00	12,300	5,610	Testaferro.	Testatiche.	18	10	18	2	48	24′ 3″	34	34,545	23′ 0″ ×	13′ 10″ ×	17′ 8¾″	26′ 2″
*4510	419·00	13,800	6,285	Testaghet.	Testaximo.	20	10	18	2	54	24′ 5″	39	39,626	23′ 0″ ×	15′ 0″ ×	18′ 2⅞″	28′ 6″
*4780	444·00	14,600	6,660	Testecilla.	Testerada.	18	12	18	2	48	24′ 3″	38	38,610	23′ 0″ ×	13′ 10″ ×	18′ 8¾″	26′ 2″
*5540	515·00	17,000	7,725	Testifichi.	Testoncino.	18	14	18	2	48	24′ 9″	42	42,674	23′ 6″ ×	13′ 10″ ×	19′ 8¾″	26′ 2″
*6182	574·00	19,000	8,610	Testimona.	Testopeca.	20	14	18	2	54	25′ 0″	46½	47,250	23′ 6″ ×	15′ 0″ ×	20′ 2⅝″	28′ 6″

* These Boilers have two steam and water drums, which are joined by a wrought steel cross pipe.

† If required for a higher working pressure than 120 lb. per square inch, in cabling add the word: **"Droguista"** for 160 lbs. pressure; or **"Duaraznero"** for 200 lbs. pressure.

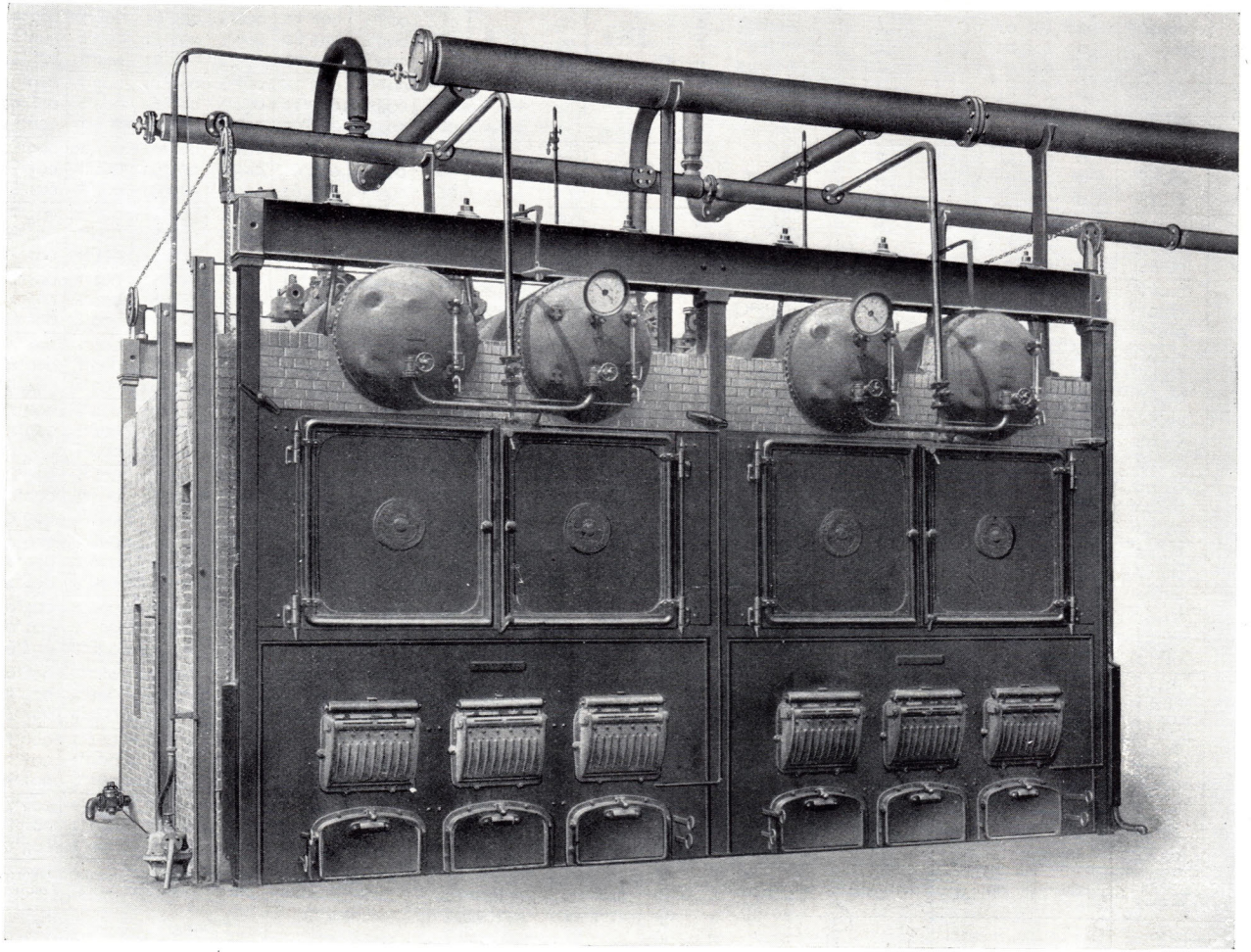
Continuation of above List. W.I.F. TYPE.

Heating Surface.		Number of Bricks required.†								Safety Valve. (Spring.)		Steam Stop Valve.	Furnace.				Heating Surface.	
		Standard Hand-fired Boiler.		Boiler set high for Hand or Mechanical Firing.‡		Boiler when fitted with Babcock & Wilcox Chain Grate Stoker, including Bricks for setting Stoker.							—		Area.			
Square Feet.	Square Metres.	Ordinary Bricks.	Fire-bricks.	Ordinary Bricks.	Fire-bricks.	Ordinary Bricks.	Fire-Bricks.	Tapered. 9×4½×3×*	Tapered. 9×6¾×3×*	No.	Diameter.	Diameter.	Width.	Length.	Square Feet.	Square Metres.	Square Feet.	Square Metres.
119	11·07	2,800	1,000	3,200	1,300	—	—	—	—	1	Double 1⅝″	2½″	2′	1″ × 2′ 6″	5·20	0·48	119	11·07
150	14·15	3,400	1,100	4,000	1,500	—	—	—	—	1	Double 1⅝″	2½″	2′	1″ × 3′ 0″	6·25	0·58	150	14·15
181	16·83	3,500	1,200	4,100	1,500	—	—	—	—	1	Double 1⅝″	2½″	2′	1″ × 3′ 6″	7·28	0·68	181	16·83
219	20·37	4,100	1,400	4,800	1,800	—	—	—	—	1	Double 1⅝″	2½″	2′	1″ × 4′ 0″	8·33	0·77	219	20·37
293	27·25	4,400	1,600	5,000	2,000	7,100	2,000	190	*2 9/16″	20	*2 9/16″	2½″	2′	8″ × 4′ 0″	10·64	0·99	293	27·25
343	31·90	4,900	1,700	5,600	2,200	7,700	2,200	190		20		2½″	2′	8″ × 4′ 0″	10·64	0·99	343	31·90
401	37·29	7,400	2,000	8,300	2,400	10,400	2,400	190	*2 9/16″	20	*2 9/16″	3″	2′	8″ × 4′ 6″	11·97	1·11	401	37·29
460	42·75	8,800	2,200	9,800	2,600	11,900	2,600	190		20		3″	2′	8″ × 5′ 0″	13·30	1·24	460	42·75
526	48·92	9,300	2,200	10,400	2,600	12,500	2,600	190		20		3″	2′	8″ × 5′ 0″	13·30	1·24	526	48·92
593	55·15	9,700	2,300	10,700	2,700	12,800	2,700	190	*2 9/16″	20	*2 9/16″	3″	2′	8″ × 5′ 0″	13·30	1·24	593	55·15
735	68·36	10,100	2,500	11,100	2,900	13,300	2,900	190		20		3″	3′	3″ × 5′ 0″	16·33	1·52	735	68·36
870	80·91	10,800	2,700	12,000	3,300	14,300	3,300	200	*2 9/16″	25	*2 9/16″	3″	3′	10″ × 5′ 0″	19·15	1·78	870	80·91
983	91·44	11,300	2,800	12,400	3,300	14,700	3,300	200	*2 9/16″	25	*2 9/16″	3″	3′	10″ × 5′ 0″	19·15	1·78	983	91·44
1098	102·11	11,600	2,900	12,700	3,400	15,000	3,400	200		25		4″	3′	10″ × 6′ 0″	23·00	2·14	1098	102·11
1218	113·27	12,900	3,300	13,800	3,700	16,100	3,700	200		25		4″	3′	10″ × 6′ 0″	23·00	2·14	1218	113·27
1265	117·76	12,800	3,400	13,600	3,700	15,900	3,700	200	*2 9/16″	25	*2 9/16″	4″	4′	5″ × 6′ 0″	26·50	2·46	1265	117·76
1411	131·22	13,200	3,500	14,000	3,800	16,300	3,800	230		30		4″	4′	5″ × 6′ 0″	26·50	2·46	1411	131·22
1426	132·62	13,400	3,500	14,300	3,900	16,600	3,900	230		30		4″	4′	5′ × 6′ 0″	26·50	2·46	1426	132·62
1619	150·58	13,600	3,600	14,500	4,100	16,900	4,100	260	*2 9/16″	30	*2 9/16″	5″	5′	0″ × 6′ 0″	30·00	2·79	1619	150·58
*1741	161·91	12,600	3,700	13,400	4,200	16,200	4,200	310	*2 11/16″	35	*2 11/16″	5″	7′	4″ × 5′ 0″	36·65	3·40	*1741	161·91
1790	166·29	14,000	3,600	14,900	4,000	17,300	4,000	260	*2 9/16″	30	*2 9/16″	5″	5′	0″ × 7′ 0″	35·00	3·25	1790	166·29
1827	169·91	14,100	3,800	15,000	4,300	17,500	4,300	270	*2 11/16″	30	*2 11/16″	5″	5′	7″ × 6′ 0″	33·50	3·11	1827	169·91
*1966	182·84	13,000	3,800	13,800	4,300	16,600	4,300	310		35		5″	7′	4″ × 5′ 0″	36·65	3·40	*1966	182·84
2010	186·72	14,500	3,800	15,300	4,200	17,800	4,200	270		30		5″	5′	7″ × 7′ 0″	39·00	3·62	2010	186·72
*2197	204·32	13,400	3,900	14,200	4,400	17,000	4,400	310	*2 11/16″	35	*2 11/16″	5″	7′	4″ × 6′ 0″	44·00	4·09	*2197	204·32
2255	209·5	14,900	3,900	15,800	4,400	18,500	4,400	310		35		6″	6′	2″ × 6′ 6″	40·00	3·7	2255	209·5
*2437	226·64	14,400	4,100	15,300	4,600	18,100	4,600	340	*2 13/16″	40	*2 13/16″	6″	7′	4″ × 6′ 0″	44·00	4·09	*2437	226·64
*2531	235·38	14,400	4,300	15,300	4,900	18,400	4,900	370	*2 13/16″	40	*2 13/16″	6″	8′	6″ × 6′ 0	51·00	4·74	*2531	235·38
*2690	250·00	14,700	4,000	15,600	4,500	18,500	4,500	370		40		6″	7′	4″ × 7′ 0″	51·00	4·74	*2690	250·00
*2823	262·54	14,800	4,400	15,800	5,000	18,900	5,000	370		40		6″	8″	6″ × 6′ 0″	51·00	4·74	*2823	262·54
*2852	265·24	15,100	4,400	16,000	5,000	19,100	5,000	370	*2 13/16″	40	*2 13/16″	6″	8′	6″ × 6′ 0″	51·00	4·74	*2852	265·24
*3140	292·00	15,400	4,300	16,400	4,800	19,800	4,800	390		45		6″	8′	6″ × 7′ 0″	59·50	5·53	*3140	292·00
*3240	301·00	15,600	4,700	16,500	5,300	20,000	5,300	390		45		6″	9′	8″ × 6′ 0″	58·00	5·39	*3240	301·00
*3580	333·00	15,900	4,600	16,900	5,100	20,500	5,100	530	*2 13/16″	45	*2 13/16″	6″	9′	8″ × 7′ 0″	67·5	6·275	*3580	333·00
*3654	340·00	16,300	5,000	17,200	5,700	21,400	5,700	530	*2 11/16″	60	*2 11/16″	7″	10′	10″ × 6′ 0″	65·00	6·05	*3654	340·00
*4020	374·00	16,600	4,800	17,600	5,400	21,800	5,400	530		60		7″	10′	10″ × 7′ 0″	76·00	7·06	*4020	374·00
*4510	419·00	17,300	5,100	18,300	5,800	22,800	5,800	600	*2 11/16″	65	*2 11/16″	7″	12′	0″ × 6′ 6″	78·00	7·24	*4510	419·00
*4780	444·00	17,600	5,000	18,500	5,600	23,100	5,600	730		60		7″	10′	10″ × 7′ 0″	76·00	7·06	*4780	444·00
*5540	515·00	18,800	5,300	19,800	5,900	24,400	5,900	730		60		7″	10′	10″ × 7′ 0″	76·00	7·06	*5540	515·00
*6182	574·00	19,600	5,600	20,600	6,300	25,500	6,300	820		65		7″	12′	0″ × 7′ 0″	84·00	7·08	*6182	574·00

* These Boilers have two steam and water drums, which are joined by a wrought steel cross pipe.

† These quantities are calculated for bricks 9 ins. by 4½ ins. by 3 ins.

‡ When boilers are to be fired mechanically they should always be set high, and the additional number of bricks required for the setting of the particular type of mechanical stokers (except in the case of Babcock & Wilcox Chain Grate Stokers, for which separate figures are given), must be added to the quantities given.



TWO DOUBLE DRUM BOILERS, SET IN BATTERY.

The heating surface allowed in the preceding list for the evaporation mentioned is ample under ordinary conditions: but, when the draught and fuel available are good, this heating surface will evaporate from 20 % to 30 % more than the figure given in the list, hence it will be seen that the size of boiler we offer, for a stated evaporation, is ample.

An ordinary non-condensing engine requires about 30 lbs. of water to be evaporated per hour in the boiler, for each H.P. it develops.

A compound non-condensing engine requires 20 to 25 lbs. of water to be evaporated per hour.

A compound condensing engine requires an evaporation of about 20 lbs. per hour.

With a triple expansion non-condensing engine the consumption is about the same, and with a triple expansion condensing engine about 15 lbs. per hour is required.

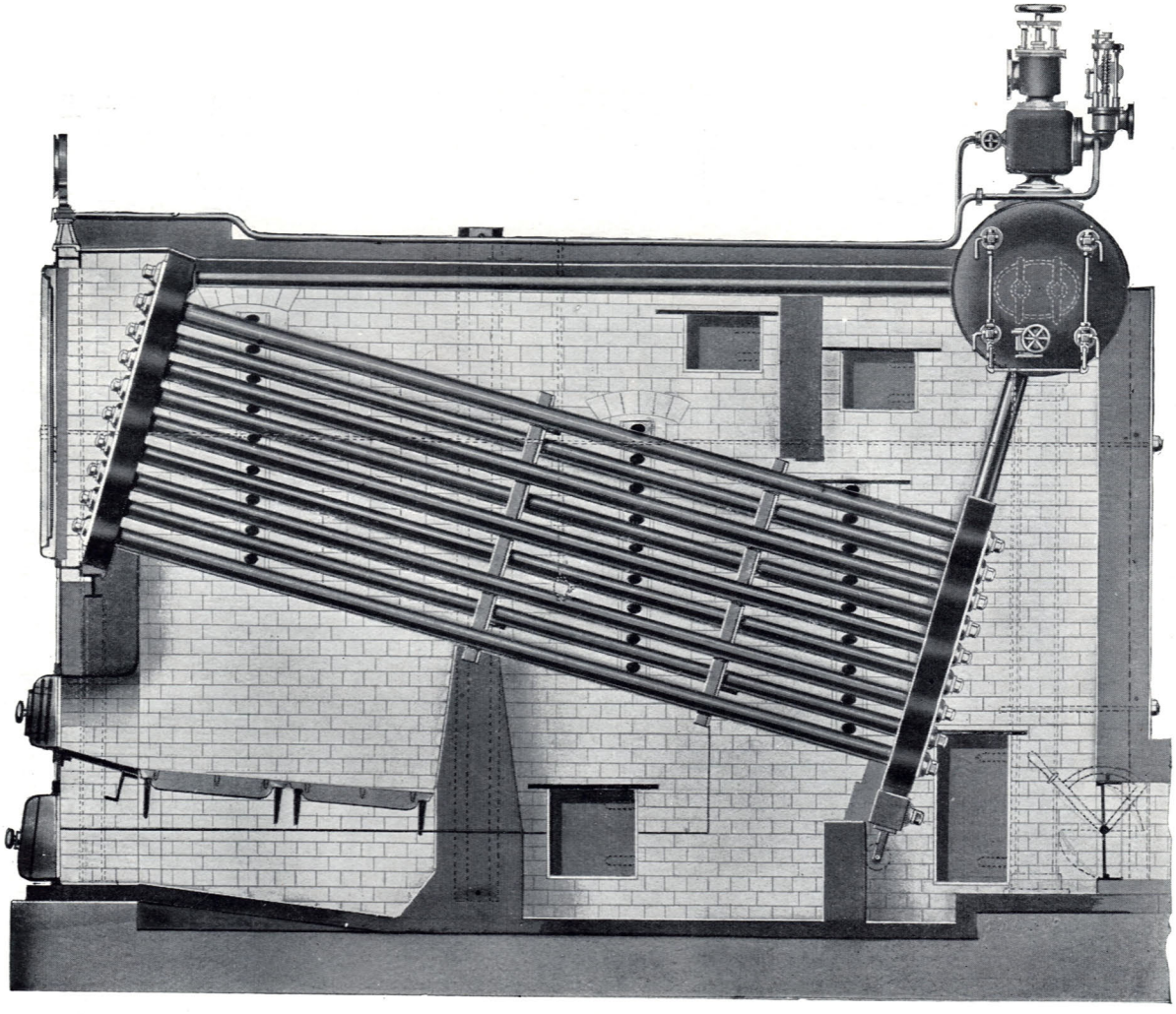
In selecting a suitable size of boiler for a certain size of engine, it is well to allow a margin for supplying pump, etc., and the following table based on this will be a guide :—

ENGINES.					BOILERS.
INDICATED HORSE POWER (APPROXIMATE).					Size of B. & W. Boiler required. *See pages* 14, 15. Heating Surface, Square Feet.
Ordinary Non-condensing.	Compound Non-condensing.	Compound Condensing.	Triple Expans. Non-condensing.	Triple Expans. Condensing.	
50	60	75	75	100	593
75	90	110	110	150	870
100	120	150	150	200	1,098
140	170	200	200	275	1,619
200	240	300	300	400	2,197

Other Sizes in proportion.

In the older Babcock & Wilcox lists the term "Horse Power" was applied to the various sizes of boilers, but they are now classified by their heating surface and evaporative capacity.

When steam is required for other purposes, such as heating, boiling, drying, etc., ample allowance in the boiler capacity must be made. It is impossible to tabulate boiler sizes for such requirements, but advice will be gladly given as to the size of boiler it is desirable to instal.



BABCOCK & WILCOX PATENT WATER-TUBE BOILER (CROSS TYPE).

For description, see page 19.

The Babcock & Wilcox Patent Water-Tube Boiler.

CROSS TYPE.

THE construction of the type of boiler illustrated on page 18, in small pieces, each of comparatively light weight, renders it specially suitable for countries where ordinary means of transport are not available.

The steam and water drum is placed transversely instead of longitudinally, as in the ordinary or W.I.F. type.

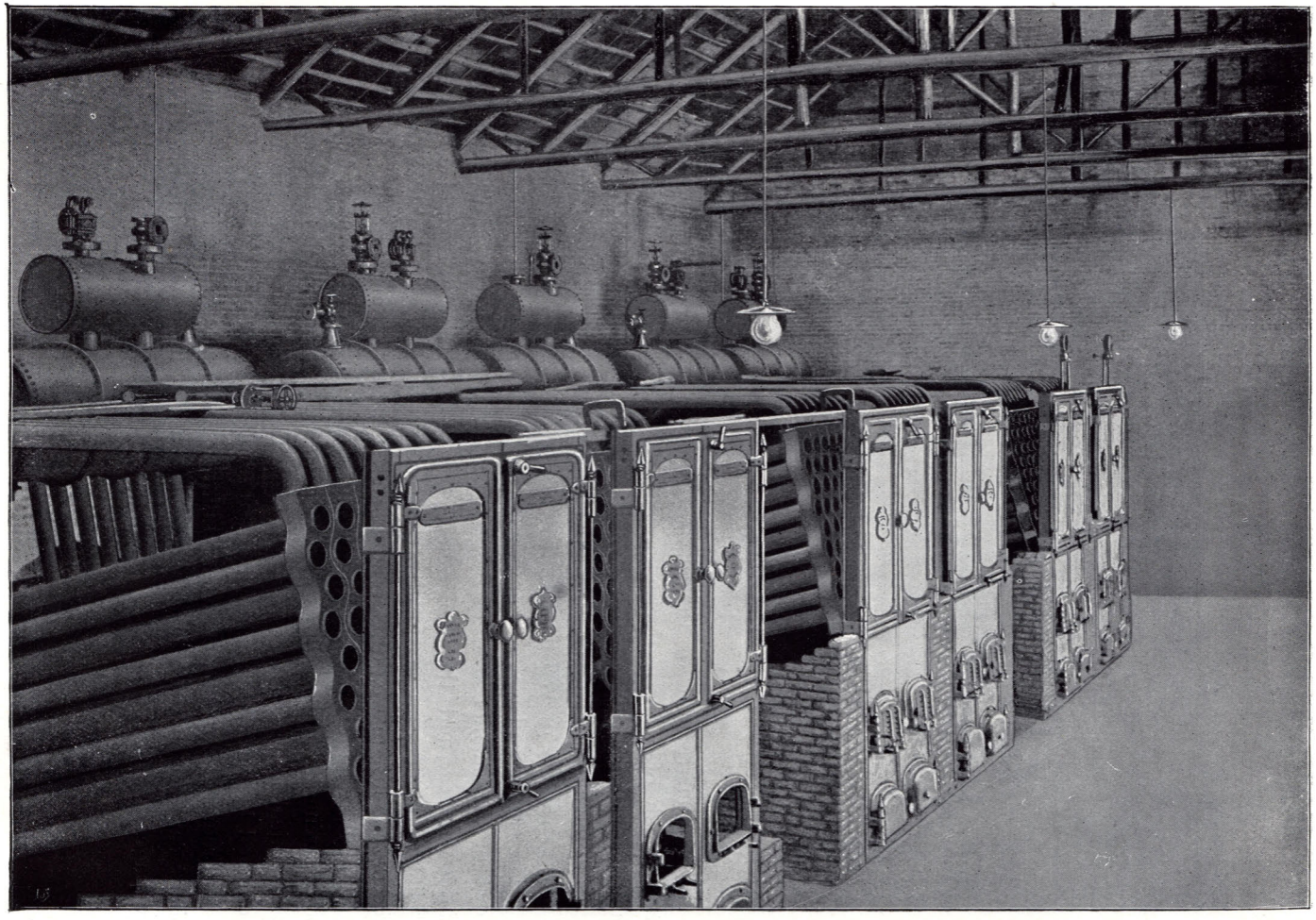
The steam and water drum—which is the heaviest part—does not exceed 8 cwt. in the smaller sizes of boilers having from 119 to 343 square feet of heating surface, and the remaining parts are all of light weight.

These Boilers are frequently constructed and shipped so that no piece exceeds 250 lbs. in weight, for mule-back transportation.

They are largely used in Indigo and Tea Plantations in India, Ceylon, etc., and are generally quite 20 to 30 per cent. more economical in fuel consumption than vertical boilers. The erection—for which full instructions are supplied—is effected by purchasers without any difficulty.

If required for districts where building materials are not readily available, boilers can be supplied with an iron casing lined with fire-brick blocks (see pages 22 to 25).

For particulars as to the various sizes of Cross-type Boilers, see page 21.



PERSIAN SUGAR REFINERY, TEHERAN, PERSIA.

Seven Babcock & Wilcox Cross-Type Boilers, each of 1,000 sq. feet heating surface, installed in 1895.
These Boilers were made in pieces not exceeding 200 lbs. in weight, and transported a long distance by mule-back.

LIST OF STANDARD SIZES OF BABCOCK & WILCOX PATENT WATER-TUBE BOILERS.

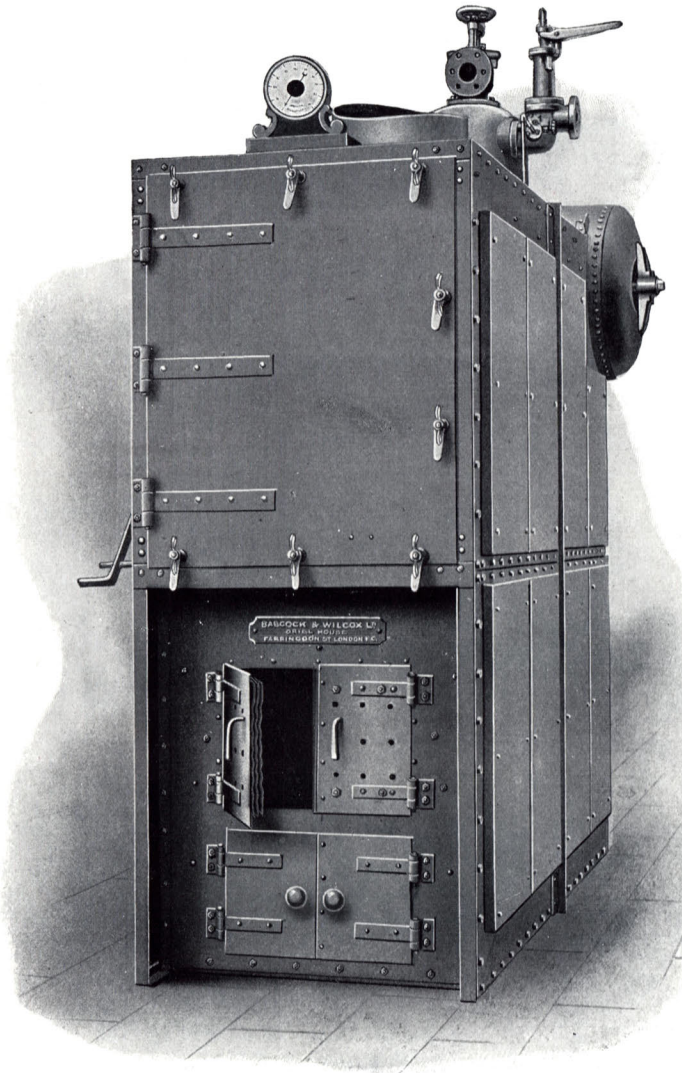
CROSS-TYPE BOILERS.

Heating Surface.		Minimum Evaporation per Hour.		Code Word.		Construction.					Approx. Total Weight (Packed).	
						Tubes.			Drum.			
Square Feet.	Square Metres.	Lbs.	Kilos.	Coal.	Wood.	Wide.	High.	Length.	Diam.	Length over Shell.	Tons.	Kilos.
119	11·07	360	165	Corona	Cubobo	3	4	6′	30″	4′ 11″	3¼	3,302
150	14·15	460	210	Coronilla	Culado	3	4	8′	30″	4′ 11″	3½	3,556
181	16·83	520	240	Corpino	Cudum	3	5	8′	30″	4′ 11″	3¾	3,810
219	20·37	660	300	Corpal	Cudejo	3	5	10′	30″	4′ 11″	4¼	4,318
293	27·25	890	405	Correal	Cubela	4	5	10′	36″	5′ 6″	5	5,080
343	31·90	1,050	480	Correro	Cudero	4	5	12′	36″	5′ 6″	5¼	5,334
401	37·29	1,200	555	Correjel	Curam	4	6	12′	36″	6′ 2″	5¾	5,842
460	42·75	1,380	630	Coreoso	Cuyac	4	6	14′	36″	6′ 2″	6⅛	6,604
526	48·92	1,600	735	Coreria	Cuxul	4	7	14′	36″	6′ 2″	6¾	6,858
593	55·15	1,800	825	Corillo	Cuzcil	4	8	14′	36″	6′ 2″	7¼	7,366
735	68·36	2,250	1,010	Corima	Cuzdal	5	8	14′	36″	6′ 9″	7¾	7,874
873	81·25	2,670	1,215	Corique	Cuzabye	6	8	14′	36″	7′ 4″	8¼	8,382
975	90·75	2,990	1,360	Corradma	Cuzacerro	6	9	14′	36″	7′ 4″	9	9,144
1075	100·00	3,300	1,500	Corsepto	Cuzadhinna	6	10	14′	36″	7′ 4″	9½	9,652
1227	114·20	3,770	1,715	Cortera	Cuzalfyco	7	10	14′	36″	7′ 11″	11½	11,684
1431	133·00	4,390	1,995	Corumsea	Cuzafeoda	8	10	14′	36″	8′ 6″	12½	12,700
1600	148·90	4,910	2,235	Corvalido	Cuzagia	9	10	14′	36″	9′ 1″	13½	13,716
1780	165·75	5,460	2,485	Corwynax	Cuzahetla	10	10	14′	42″	9′ 8″	14⅝	14,986
1966	182·00	6,000	2,730	Corxona	Cuzaic	11	10	14′	42″	10′ 3″	16	16,250
2150	200·00	6,600	3,000	Corzadilla	Cuzakecca	12	10	14′	42″	10′ 10″	17¾	18,040
2455	228·25	7,530	3,425	Corzecca	Cuzajea	14	10	14′	42″	12′ 0″	19⅞	20,066
2860	266·00	8,770	3,990	Corzedyl	Cuzalendra	16	10	14′	42″	13′ 2″	22¾	23,114

Space Occupied.			No. of Bricks Required.		Double Safety Valve (Spring).		Stop Valve.	Furnace Area.				Heating Surface.	
Over Brickwork.		Height to Centre Stop Valve.											
Length.	Width.		Common.	Fire.	No.	Diam.	Diam.	Width.	Length.	Square Feet.	Square Metres.	Square Feet.	Square Metres.
9′ 7″	4′ 5″	10′ 0 3/8″	2,700	900	1	2″	2½″	2′ 1″	2′ 6″	5·20	0·48	119	11·07
11′ 8″	4′ 5″	10′ 0 3/8″	3,000	1,000	1	2″	2½″	2′ 1″	3′ 0″	6·25	0·58	150	14·15
11′ 10″	4′ 5″	10′ 6 3/8″	3,100	1,100	1	2″	2½″	2′ 1″	3′ 6″	7·28	0·68	181	16·83
13′ 10″	4′ 5″	10′ 6 3/8″	3,700	1,300	1	2″	2½″	2′ 1″	4′ 0″	8·33	0·77	219	20·37
14′ 1″	5′ 0″	10′ 9 3/8″	3,900	1,300	1	2″	2½″	2′ 8″	4′ 0″	10·64	0·99	293	27·25
16′ 2″	5′ 0″	10′ 9 3/8″	4,300	1,600	1	2″	2½″	2′ 8″	4′ 0″	10·64	0·99	343	31·90
16′ 4″	5′ 8″	12′ 3 7/8″	6,500	1,900	1	2″	3″	2′ 8″	4′ 6″	11·97	1·11	401	37·29
18′ 5″	5′ 8″	12′ 3 7/8″	8,000	2,100	1	2″	3″	2′ 8″	5′ 0″	13·30	1·24	460	42·75
18′ 6″	5′ 8″	12′ 9 7/8″	9,200	2,100	1	2″	3″	2′ 8″	5′ 0″	13·30	1·24	526	48·92
18′ 8″	5′ 8″	13′ 3 7/8″	9,500	2,100	1	2″	3″	2′ 8″	5′ 0″	13·30	1·24	593	55·15
18′ 8″	5′ 8″	13′ 3 7/8″	9,700	2,300	1	2″	3″	3′ 3″	5′ 0″	16·25	1·51	735	68·45
18′ 8″	6′ 10″	13′ 3 7/8″	10,500	2,400	1	2″	3″	3′ 10″	5′ 0″	19·15	1·78	873	81·25
18′ 9″	6′ 10″	13′ 11 1/8″	11,500	2,400	1	2″	4″	3′ 10″	5′ 0″	19·15	1·78	975	90·75
18′ 11″	6′ 10″	14′ 5 1/8″	11,700	2,600	1	2″	4″	3′ 10″	5′ 6″	21·07	1·96	1075	100·00
18′ 11″	7′ 5″	14′ 11 1/8″	13,100	2,900	1	2″	4″	4′ 5″	5′ 6″	24·30	2·26	1227	114·20
18′ 11″	8′ 0″	14′ 11 1/8″	13,500	3,100	1	2½″	4″	5′ 0″	5′ 6″	27·50	2·56	1431	133·00
18′ 11″	8′ 7″	14′ 11 1/8″	13,700	3,300	1	2½″	5″	5′ 7″	5′ 6″	30·70	2·86	1600	148·90
18′ 11″	9′ 2″	15′ 2 7/8″	14,000	3,600	1	2½″	5″	6′ 2″	5′ 6″	33·82	3·15	1780	165·75
18′ 11″	9′ 9″	15′ 2 7/8″	14,200	3,800	1	2½″	5″	6′ 9″	5′ 6″	37·18	3·47	1966	182·00
18′ 11″	10′ 4″	15′ 2 7/8″	14,500	4,000	1	2½″	6″	7′ 4″	5′ 6″	40·40	3·76	2150	200·00
18′ 11″	11′ 6″	15′ 4 7/8″	14,700	4,100	1	3″	6″	8′ 6″	5′ 6″	47·75	4·44	2455	228·25
18′ 11″	12′ 8″	15′ 4 7/8″	14,900	4,200	1	3″	6″	9′ 8″	5′ 6″	53·00	4·93	2860	266·00

NOTE.—Walls of boilers up to 343 sq. feet heating surface 14″ thick ; for 401 sq. feet heating surface and upwards 18″ thick.

Constructed for a working pressure of 120 lbs. to the square inch. If required for a higher working pressure than 120 lbs. per square inch, in cabling add the word **"Droguista"** for 160 lbs. pressure, or **"Duaraznero"** for 200 lbs. pressure.



FRONT VIEW.

BABCOCK & WILCOX PATENT WATER-TUBE BOILER (PORTABLE TYPE),

Fitted with Wrought Iron Casing and Chimney.

The Babcock & Wilcox Patent Water-Tube Boiler.

PORTABLE TYPE.

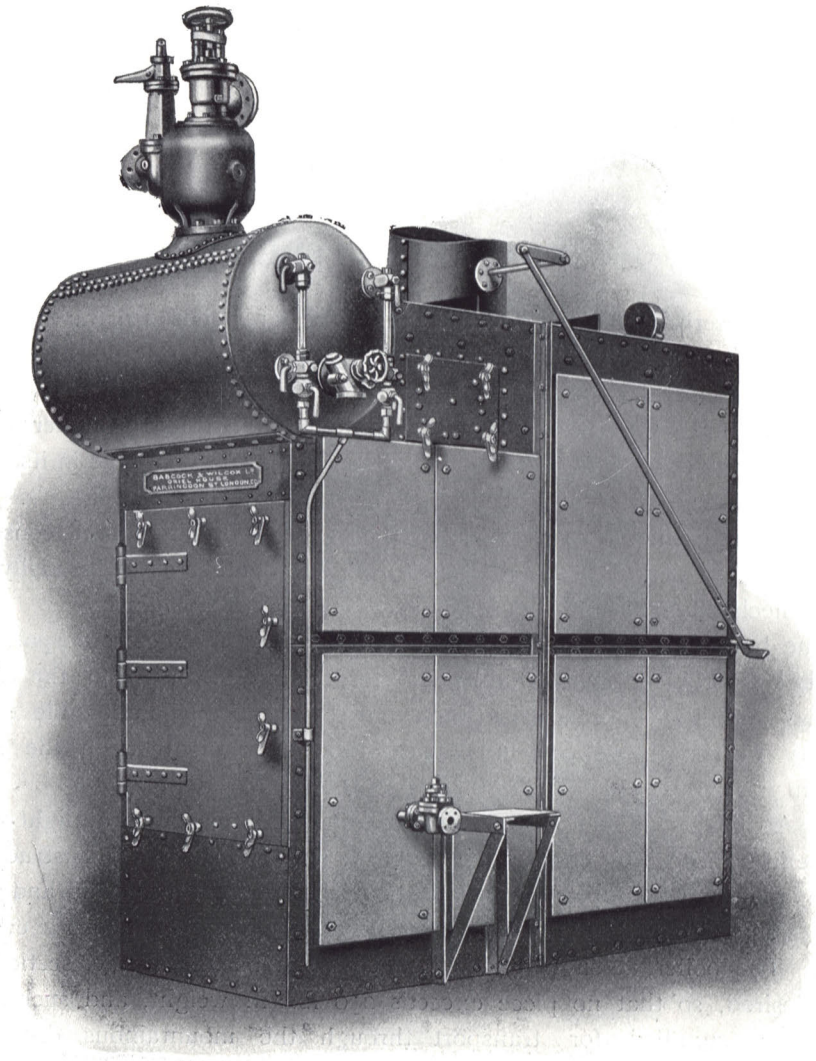
THE description given for the cross-type of boiler will apply to the portable boiler, the only difference being that with the latter no brickwork is required, nor any independent chimney, and in comparing the cost of the boiler, it should be borne in mind that, although the price is higher than in the case of the other types, yet the boiler as shipped is complete in itself, with the iron casing, chimney, and all fittings.

The iron casing is so constructed that loss by radiation, and consequent waste of fuel, is minimised, and it is so bolted together as to be easily fitted by any mechanic.

The boiler is erected complete, with its iron casing, before despatch, and an index is provided, with numbers corresponding to those on the erection drawings and the shipping list; hence it is practically impossible for any difficulty to be experienced in putting the boiler together on the site of erection.

These boilers are shipped in sections, in small packages of light weight, for ease in transport by coolie or mule-back, and are specially constructed for use in mountainous districts. The heaviest piece, the steam and water drum, weighs from 8 to 12 cwt., all other parts being of about 2 cwt. and under. The boiler, at slightly increased cost, can be still further sectionalised when desired, so that no piece exceeds 250 lbs. in weight, and such boilers have been supplied for transport through the mountainous districts in Afghanistan, India, Japan, South and West Africa, Egypt, Australia, South and Central America, &c., &c.

For particulars as to various sizes of Boilers see page 25.



BACK VIEW.

BABCOCK & WILCOX PATENT WATER-TUBE BOILER (PORTABLE TYPE),

Fitted with Wrought Iron Casing and Chimney.

LIST OF STANDARD SIZES OF BABCOCK & WILCOX PATENT WATER-TUBE BOILERS.

PORTABLE TYPE.

Heating Surface in square feet.	† With Coal of Fair Quality.					† With Dry Wood Fuel.					† With Sawdust.					Chimney.		Weight of Boiler (packed).		Weight of Steam and Water Drum (Class A).
	Evaporation.	Indicated H.P., with single cylinder, non-condensing Engine.	Indicated H.P., with compound non-condensing Engine.	Code Word for Boiler (Class A).	Code Word for Boiler (Class B).	Evaporation.	Indicated H.P., with single cylinder, non-condensing Engine.	Indicated H.P., with compound non-condensing Engine.	Code Word for Boiler (Class A).	Code Word for Boiler (Class B).	Evaporation.	Indicated H.P., with single cylinder, non-condensing Engine.	Indicated H.P., with compound non-condensing Engine.	Code Word for Boiler (Class A).	Code Word for Boiler (Class B).	Dia. in ins.	Height in ft.	Tns.	Cts.	Cwts.
	Lbs. per hour.					Lbs. per hour.					Lbs. per hour.									
174	750	25	30	Portabo.	Portabird.	650	20	26	Portwood.	Portwabar.	520	17	20	Portsaw.	Portsbone	14	15	7	10	$8\frac{1}{2}$
316	1,400	46	56	Portacce.	Portabane	1,250	40	50	Portwara.	Portwabun.	1,000	30	40	Portseed.	Portsbait.	20	15	8	10	10
513	2,250	75	90	Portaden.	Portabole.	2,000	65	80	Portweed.	Portwabit.	1,600	50	60	Portsinto.	Portsbent	24	19	13	11	10
612	2,700	90	108	Portaefall.	Portalifox.	2,400	80	96	Portwheel	Portwaboyd.	1,950	65	78	Portsoday	Portsbroth	24	19	14	12	10
779	3,450	115	138	Portafin.	Portabene.	3,000	100	120	Portwoke.	Portwabed.	2,450	81	98	Portsone.	Portsbine.	26	23	16	6	$11\frac{1}{2}$
997	4,350	145	174	Portagor.	Portablay.	3,900	130	156	Portwight	Portwaboon.	3,100	103	124	Portsurf.	Portsbud.	26	26	19	0	13
1,215	5,300	176	212	Portahobe	Portabred.	4,700	156	188	Portwone.	Portwabeat.	3,800	126	152	Portsutor.	Portsbye.	34	27	21	4	$14\frac{1}{4}$
1,433	6,300	210	252	Portaille.	Portabseal	5,600	186	224	Portwobble.	Portwabyx.	4,500	150	180	Portsuvey	Portsbymk	36	37	23	5	16

† Constructed for a working pressure of 120 lbs. per square inch. If required for a higher working pressure than 120 lbs. per square inch, in cabling, add the word "DROGUISTA" for 160 lbs. pressure, or "DUARAZNERO" for 200 lbs. pressure.

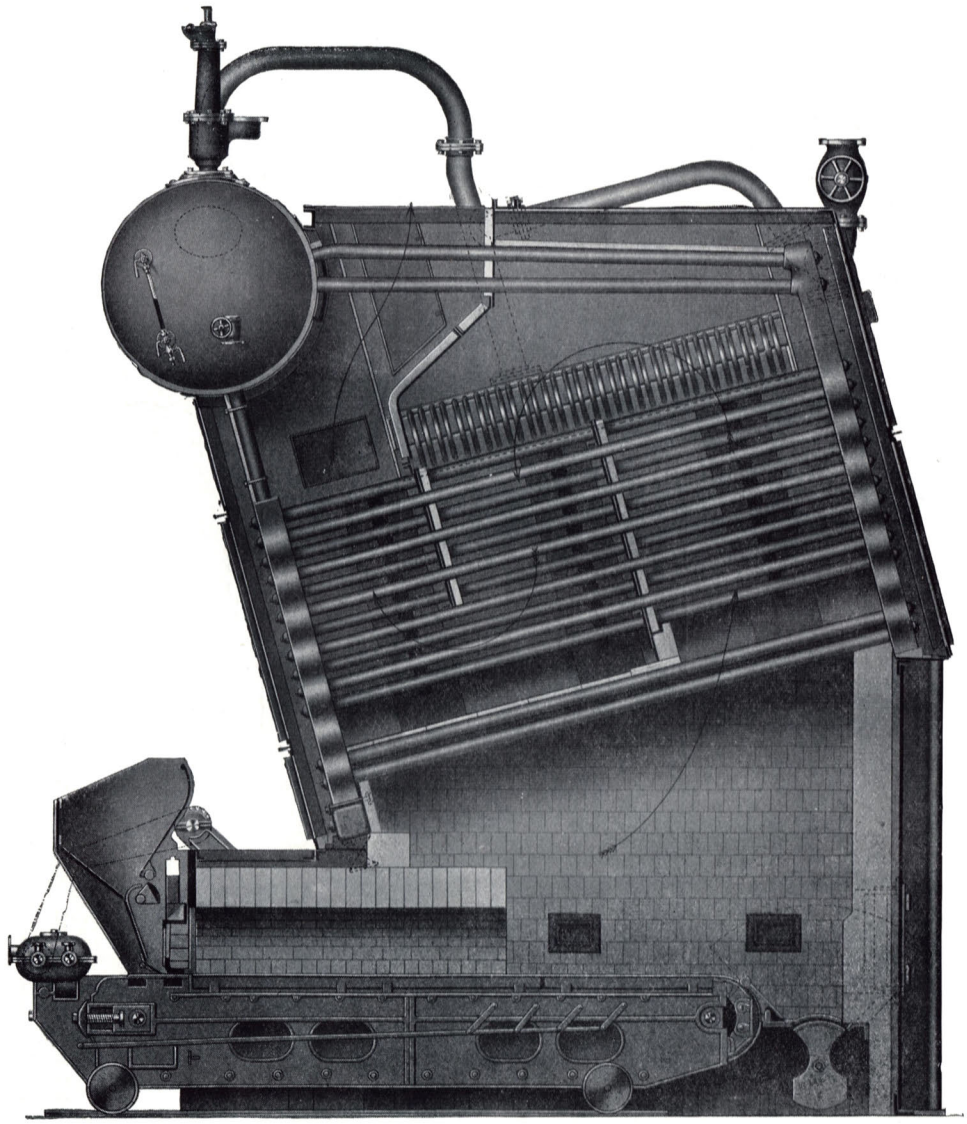
The Boilers are complete with all Steam and Fire Mountings, an Expander for erection, and a Chimney, are packed for export, and delivered f.o.b. Glasgow.

The horse-powers given in this List are approximately the indicated horse-powers which will be developed in single cylinder high-pressure engines, and in compound non-condensing engines of good construction. When working with condensing engines the indicated horse-power developed would be about 15 per cent. greater.

Separate Code Words are given for Boilers to burn coal, wood, and shavings, and the style of grate and area will be proportioned accordingly. When cabling for a boiler to burn other classes of fuel use the code word for a coal fired boiler, followed by the name of the fuel to be burnt.

The total dead weight of each boiler, and the weight of the heaviest piece—the steam and water drum—is stated in the above List for the various sizes in Class A; the other parts are all of light weight, *i.e.*, not exceeding 250 lbs.

In Class B the drums are sectionalised, so that no piece exceeds 250 lbs.



BABCOCK & WILCOX PATENT WATER-TUBE STEAM BOILER (Marine-Type for Land Purposes),

Fitted with Patent Superheater and Patent Chain Grate Stoker.

With part of Casing removed.

The Babcock & Wilcox Patent Water-Tube Boilers.

MARINE TYPE FOR LAND PURPOSES.

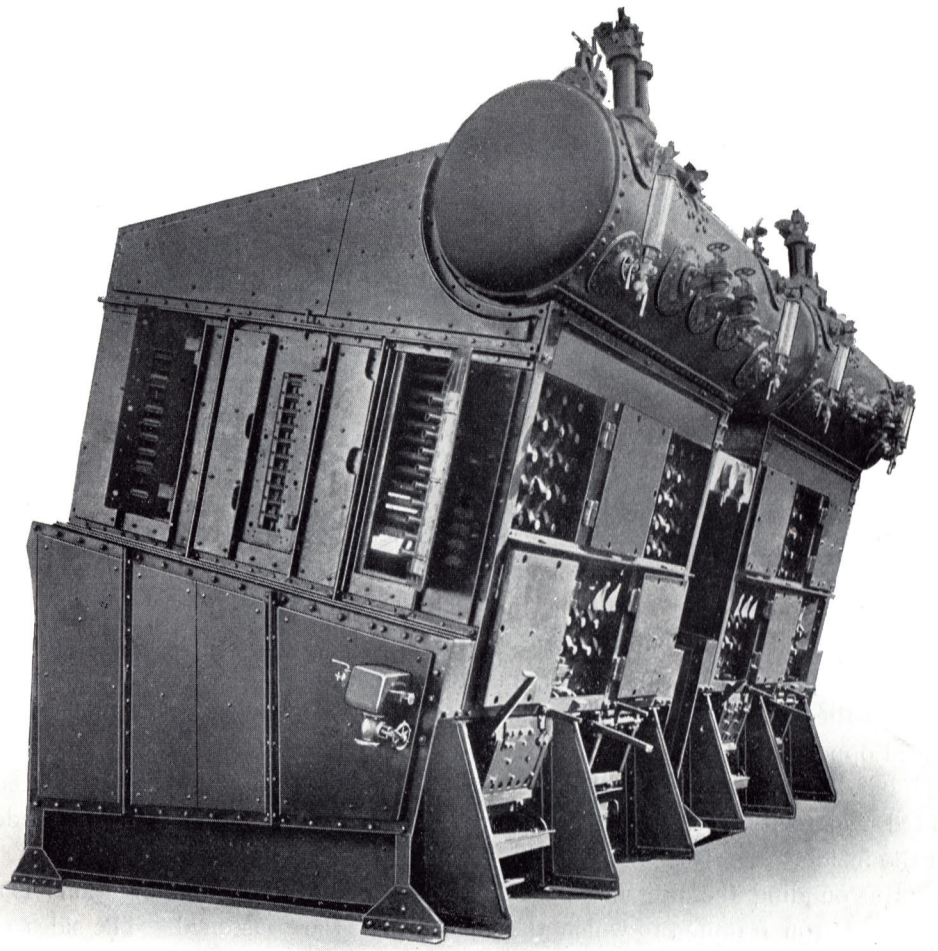
THE BABCOCK & WILCOX MARINE-TYPE BOILER is equally adapted for installation on land as on board ship, and is especially suitable for Electricity Generating Stations and quick steaming plants, and offers advantages in economy of space, safety, and efficiency. It embodies the same well-known principles of construction as the Babcock & Wilcox Land, or Stationary, Boiler, which has met with such remarkable success during the past thirty years.

The boiler is constructed entirely of wrought steel, and consists of straight tubes forming the heating surface, which are divided into vertical sections, and placed at an inclination of 15° with the horizontal. These tubes are expanded at each end into wrought steel staggered headers, with an ordinary boiler tube expander. The horizontal steam and water drum is placed at the front of the boiler, above the lower ends of the inclined tubes, connected underneath to the downtake headers by short vertical tubes, and to the uptake headers by horizontal tubes. The mud-drum, extending the whole width of the boiler, is fixed at the bottom of the downtake headers by short tubes. Handholes are placed opposite the end of each tube, to permit of its being cleaned or renewed, each handhole being closed by a forged-steel handhole plate. This plate is faced and drawn to its seat by a forged steel cap and nut, the joint being made on the inside.

Surrounding the pressure parts and firmly bolted to the foundations is a structural iron framing, to which the casing plates are fastened. The sides of the furnace are composed of firebricks, the whole structure being surrounded by removable wrought-iron casings lined with non-conducting composition. Hinged doors are fitted to the casing at front and rear, to admit of access to the handhole fittings, and there are also doors in the side of the casing for the removal of soot from the exterior of the tubes

Among the many advantages of the boiler are comprised its perfect circulation, rapid steaming combined with economy of fuel, safety under the highest pressures, and accessibility for cleaning and inspection.

The iron casing prevents the infiltration of air, unavoidable with all brickwork settings.



BABCOCK & WILCOX PATENT WATER-TUBE MARINE BOILER.

View of Two Boilers installed in the Mercantile Marine.

The Babcock & Wilcox Patent Water-Tube Boiler.

MARINE TYPE.

THE general design of boiler, constructed for Merchant Ships, will be seen by reference to the illustration, page 28, the detailed arrangement, including the number, size, and length of the tubes, varying with the power required.

The boiler is constructed entirely of wrought steel, and consists of a series of inclined water tubes, under which the furnace is placed; these tubes are expanded into sinuous connecting boxes of rectangular section, called "Headers," at front and rear, the headers being connected by tubes to a steam and water drum, and a mud drum.

The steam generated in the inclined tubes, together with the unevaporated water, is conveyed by tubes from the top of the rear headers to the drum, in which the steam is liberated, and the remaining body of water returns to the inclined tubes through the short tubes connecting the front headers to the drum.

The bottom of each header is connected by short tubes to a wrought steel mud drum, fitted with a blow-off cock for removing deposit.

The sides of the boiler are formed of removable wrought-iron casing, lined with suitable non-conducting material, in addition to which specially shaped fire-bricks are fitted against the side tubes of the boiler, thus forming an additional means of retaining the heat.

Depending upon the arrangement of boilers in the ship, the fire-doors may also be under the higher end of the sections of tubes.

These boilers are constructed to the requirements of the British Admiralty, Board of Trade, Lloyd's, and Bureau Veritas, and are suitable for Battleships, Passenger and Cargo Vessels, and Tugboats.

The Babcock & Wilcox Marine Boiler is dealt with more fully in our Marine Catalogue, a copy of which can be had upon application.

Information

Regarding the Brickwork Setting of Babcock & Wilcox Boilers.

(W.I.F. TYPE.)

WHILST the setting of a Babcock & Wilcox boiler consists practically of straight walls only with a fire-brick lining, and is of such a character that any good bricklayer can carry it out without any difficulty whatever, the following points may be particularly noted :—

The Babcock & Wilcox boiler of the W.I.F. type is carried on iron standards, independently of the brickwork, hence the foundation under these standards should be solid.

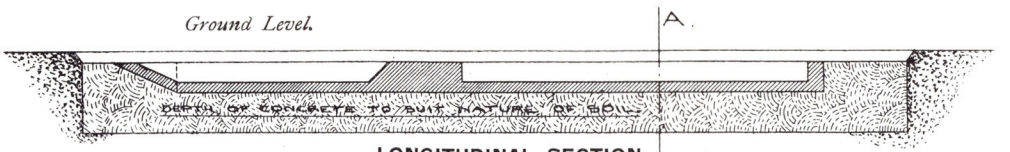
The brick walls have only their own weight to carry, and require therefore no other foundations than are usually required for walls of the same thickness and height. Where the soil is of a light nature, however, it is desirable to put a block of concrete under the whole surface occupied by the boiler.

This bed of concrete should be brought up to a higher level at each end, and the upper surface of these raised portions left perfectly level and rendered smooth ready to receive the bases of the iron standards, referred to above, for carrying the boiler.

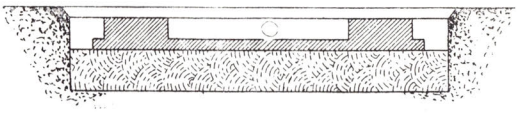
The weight of the boiler rests on the raised portions, and the concrete bed should be taken down sufficiently deep at these points to ensure a solid foundation, the depth depending on the nature of the soil.

In some cases it is more convenient to make the concrete bed level throughout, with stones bedded on it to carry the bases of the boiler columns. If stones are used, marked P on the illustrations (page 32), they should be solidly bedded on the concrete, and all at the same level. If the upper surface of the stones should be much above the level of the concrete, they should be bedded on brick piers. In this case the piers should be built of hard brick set in cement.

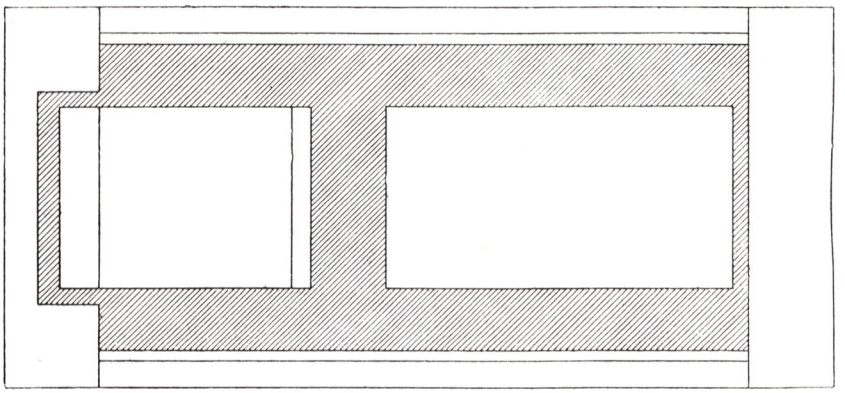
The joints of the brickwork should be kept as thin as possible. The ordinary bricks should be bedded in ordinary mortar, and the fire-bricks in fire-clay. It is particularly desirable that the joints between the fire-bricks should be as thin as possible. The best thing is merely to dip the bricks in fire-clay, mixed with water to the consistency of paint, so that there is no appreciable thickness of joint between the bricks.



LONGITUDINAL SECTION.



CROSS SECTION A B.



PLAN.

THE FOREGOING ILLUSTRATIONS SHOW HOW FAR THE FOUNDATIONS AND CONCRETE BED SHOULD BE PREPARED PREVIOUS TO ERECTION OF THE BOILER.

Where the brickwork touches the drum, fire-clay only should be used; mortar containing lime should not come into contact with any parts of the boiler proper.

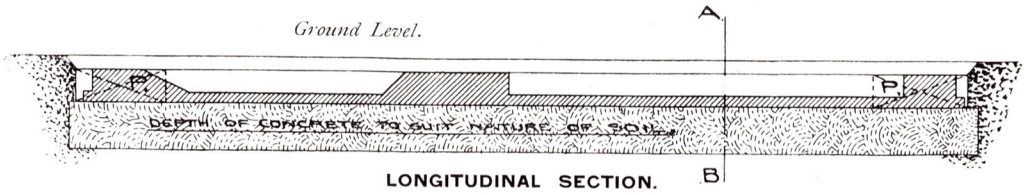
The cleaning doors should be substantially built in.

At the top of the boiler side walls a chase should be left, into which the non-conducting composition, with which the boiler should be covered, is joined.

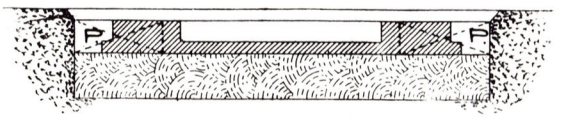
It is an advantage to build the top course of the boiler side walls of hard brick set in cement, so that it is not damaged by the attendant walking upon it.

For building the arches over the fire-doors, key bricks should be used, and the circle of the fire-door arch should correspond to the circle of the fire-door casting, and be in line with it.

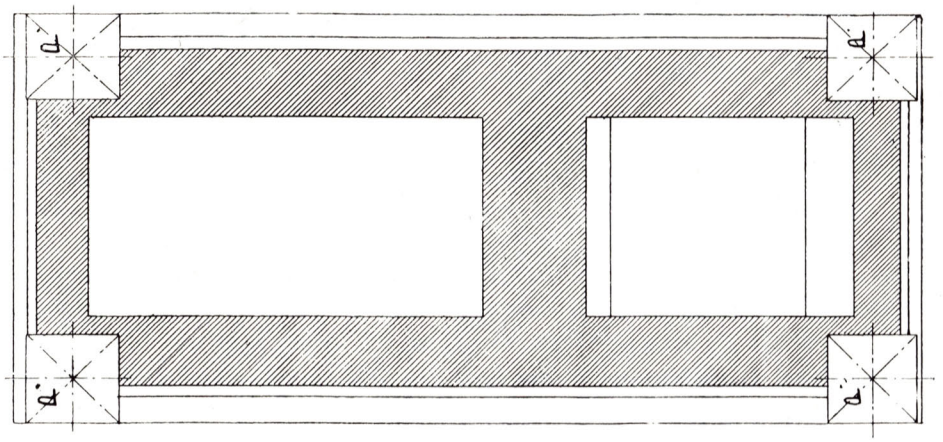
Before firing the boiler, the brickwork should be dried for a couple of days by means of a light fire. In damp wintry weather extra care is necessary, and fires should be burning for a longer period. Any cracks appearing at this time, or on subsequently firing the boiler, due to expansion and contraction and the drying of the mortar, should be at once cared for by scraping the mortar out and re-pointing whilst the brickwork is hot.



LONGITUDINAL SECTION.

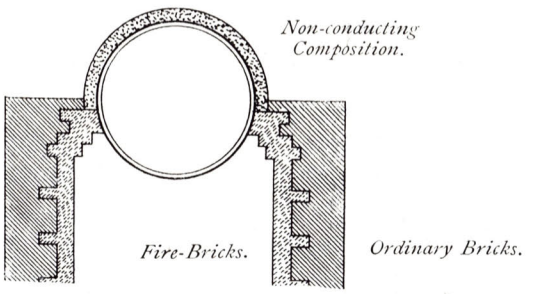


CROSS SECTION A B.



PLAN.

THE ABOVE ILLUSTRATIONS SHOW HOW FAR THE FOUNDATIONS AND BRICKWORK FOOTINGS SHOULD BE PREPARED PREVIOUS TO ERECTION OF BOILER.



CROSS-SECTION SHOWING FIRE-BRICK LINING TO SIDE WALLS, AND NON-CONDUCTING COMPOSITION COVERING THE STEAM AND WATER DRUM OF BOILER.

Babcock & Wilcox Steam Superheaters

(Integral with Boiler).

AT the present time, when the keenness of competition in manufacturing, and in the use of motive power generally, is so great, engineers and steam users are diligently seeking methods of economising fuel. Much has been done during the last two or three decades in this direction, for, down to then, the engines principally in use were of the Cornish type, working at very low pressures, and requiring five or six pounds of coal per I.H.P. per hour, and in many cases considerably more.

The modifications which have led to present-day results have been principally greater piston speed, higher steam pressures, and the recognition of the sources of waste that take place in the engine itself.

Higher pressures and greater piston speeds have led to the development of triple-expansion and quadruple-expansion engines, working at pressures of 200 lbs. and upwards; and the **water-tube boiler, which is the latest development in steam generators,** is generally admitted to be an essential improvement in connection therewith.

Of the sources of waste in an engine, the condensation of steam from the cooling effects of the cylinder walls, or cylinder condensation as it is called, is by far the greatest. This was recognised, even early in the last century; but in 1855, for the first time, the extent of this loss was established in a definite manner by Hirn. In more recent years, Professor Dwelshauvers-Déry, Mr. Walther Meunier, of the Alsatian Association of Steam Users; Professor Wm. C. Unwin, and others, have given much of their time and thought to this question.

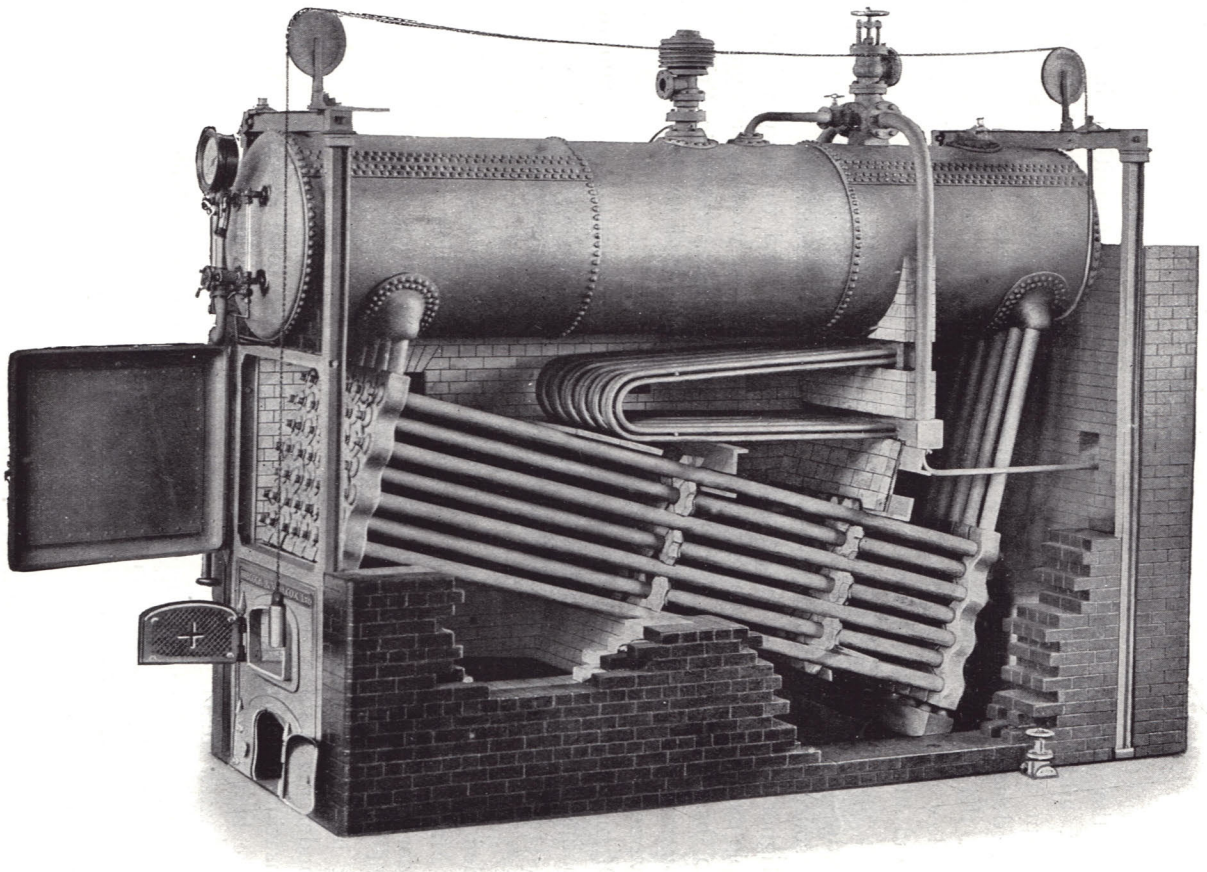
It has been established, practically, that in an ordinary single cylinder non-condensing engine, with an early cut-off, the waste through cylinder condensation amounts to from 35 % to 40 % of the total steam used.

The best means of partially or wholly preventing this loss is by the use of superheated steam.

Steam is said to be superheated when, at any given boiler pressure, it has a higher temperature than the water from which it was evaporated.

Water, no matter from what cause arising, cannot exist in the presence of superheated steam; it robs the steam of its extra heat, and is itself evaporated into steam.

The temperature of saturated steam cannot be raised without increasing its pressure; but the temperature of superheated steam allowed to expand can be raised without increasing the pressure. Expansion is provided for by the steam being drawn off and used, or, if no steam is used, by the safety valve lifting. We mention this to prevent any erroneous impression that superheating



THE BABCOCK & WILCOX BOILER, FITTED WITH SUPERHEATER (Integral with Boiler).

steam causes the production of excessive pressures in boilers, and consequently entails more danger in ordinary working.

From time to time various attempts have been made to supply superheated steam to engines, both on land and on board ship. In the latter connection, Mr. John Penn, the famous engineer, made many trials, and stated, in his papers read before the Institution of Mechanical Engineers in 1859–1860, that with 100° to 120° F. of superheat, an economy of 20% to 30% in fuel consumption was obtained on some of the steamers in which superheating was adopted.

At that time the application of superheaters was spasmodic, due to mechanical defects in the superheaters themselves or in their application. The inaccessibility of their position brought them into disfavour, and the lack then of suitable cylinder lubricating oils increased the difficulties. Now, however, superheaters are again being successfully fitted to marine boilers.

The *rationale* of the use of superheated steam is not only the prevention of loss through condensation in steam pipes, but the addition of such an amount of superheat to the steam, before it enters the cylinder, as will make up for that robbed by the cylinder walls, so that the steam will remain practically dry, at all events up to the point of cut-off.

Bearing in mind what has already been done, we find that the principles on which a superheater should be constructed, to give a sufficiently high temperature, are :—

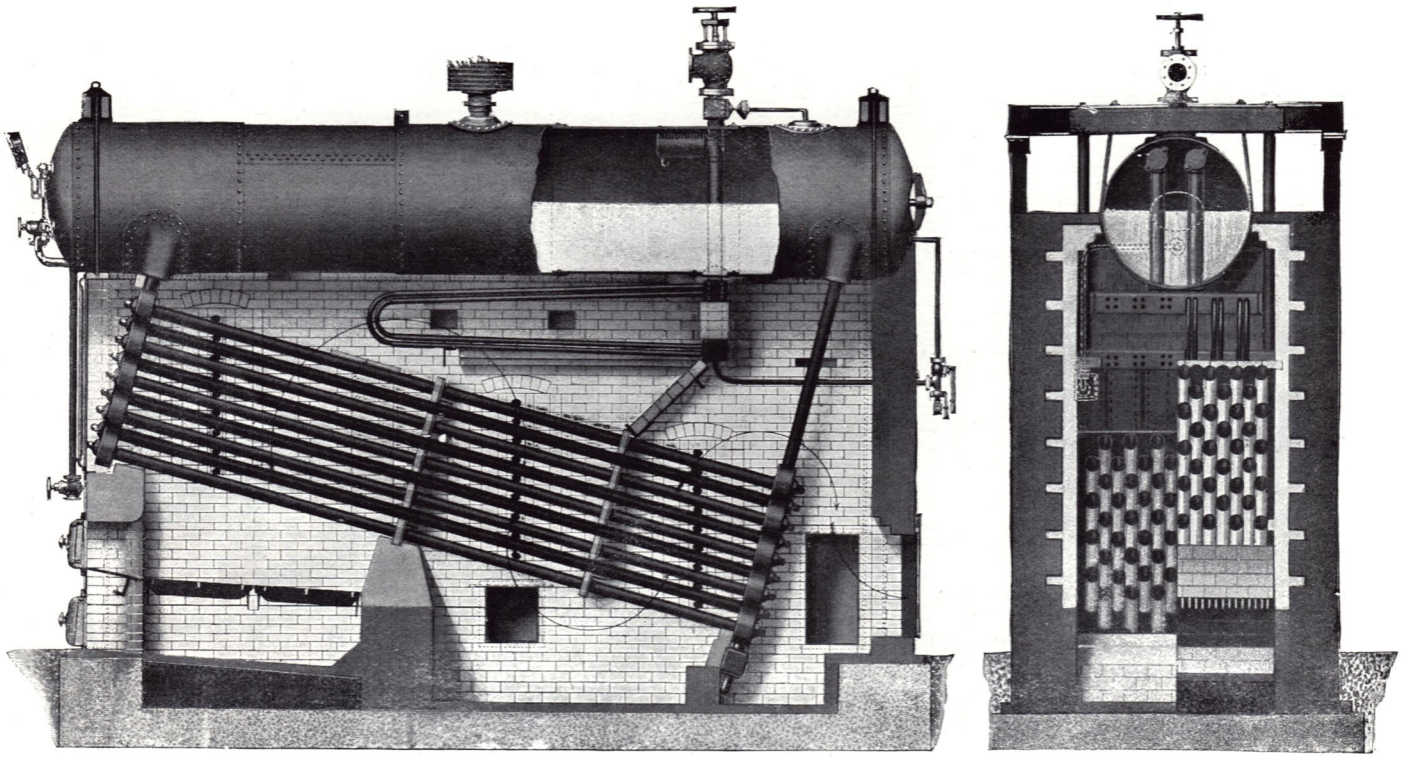
Firstly.—The necessity of placing the superheater in a position where a suitable temperature is available. If a boiler is working under economical conditions, the difference between the temperature of saturated steam and of the escaping flue gases leaving a boiler is not sufficient to superheat the steam produced, unless the surface of the superheater be very large ; hence, generally speaking, a superheater should not be placed in the flue between boiler and chimney. On the other hand, if placed too near to the boiler furnace, possibly damage would result from the impact of flame.

Secondly.—The superheater should be constructed to admit of all its parts expanding and contracting freely, without severe strains being put on any of the joints, which might cause them to leak ; flanged joints, when exposed to furnace gases, should be avoided wherever possible.

Thirdly.—Provision should be made to protect the superheater against overheating when steam is not passing through it sufficiently to carry away the heat supplied by the furnace gases.

The Babcock & Wilcox Patent Integral Superheater (shown on page 34) fulfils all these conditions.—It is placed in a position where there is practically no deteriorating condensation of the gases, and where the temperature is sufficiently high to ensure the steam receiving from 100° to 150° F. of superheat, or more if desired.

This superheater is not subject to the immediate impact of the fire, as the furnace gases must first pass through the front part of the boiler, which



BABCOCK & WILCOX PATENT WATER-TUBE BOILER, FITTED WITH PATENT SUPERHEATER
(Integral with Boiler).

comprises a considerable heating surface. Assuming the boiler to be in regular work, and the firing even, no great fluctuations in temperature can take place where the superheater is fixed. Moreover, it is readily accessible for examination, and for the renewal of tubes.

There are no flanged joints, all the tube joints are expanded.

Freedom for expansion is provided for by the tubes being free at one end, and by the manifolds not being rigidly connected with each other.

As will be seen, the tubes are bent into a "U" shape, and connected at both ends with manifolds, one of which receives the saturated steam from the boiler, the other collecting the steam after it has traversed the superheater tubes, and delivering it to the valve, placed above the boiler.

Prevention against overheating during steam raising from a cold boiler is ensured by the arrangement for flooding with boiler water.

The flooding arrangement consists of a connection with the water space of the boiler drum, and two cocks, by means of the larger of which the water can enter the lower manifold and fill the superheater to the boiler water level. Any steam formed in the superheater tubes is returned into the boiler drum through the inlet pipes, which, when the superheater is at work, convey saturated or natural steam into the upper manifold. Before putting the boiler into work by opening the superheater stop valve and using superheated steam, the water is drained away from the superheater by the flooding pipe and the smaller cock. A sight glass is attached to the drain outlet for observing when all the water has been drawn out of the superheater.

In general practice from 100° to 150° F. of superheat is usually provided for in the proportion of superheating surface to boiler heating surface adopted, and it has been found by experiment that even with the most refined triple expansion engines, working under ordinary conditions, an economy of from 10% to 15% can be regularly obtained. With engines less refined, or of slower piston speed, of course the percentage of saving is greater.

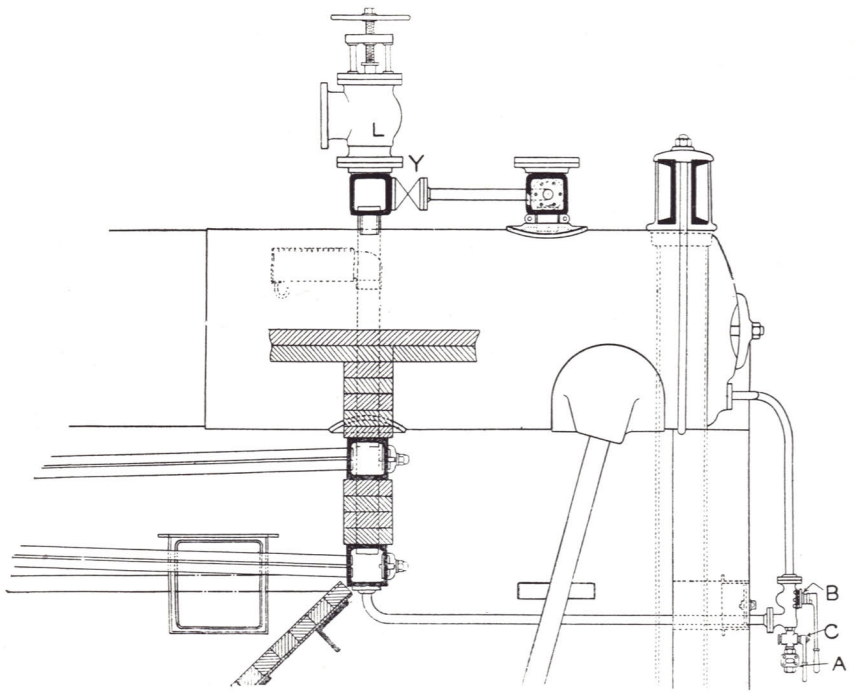
In many cases steam superheated 250° to 300° F. is employed, and numbers of our superheaters are working most satisfactorily under these conditions.

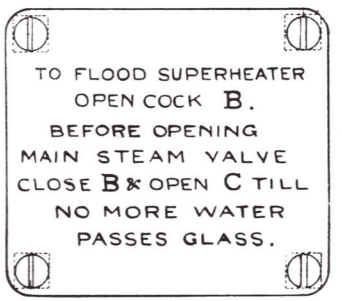
There are at the present day over 12,000 Babcock & Wilcox Superheaters in use, and they have stood the test of durability for several years. Many tests for increased economy have been made, and the saving in fuel has been undeniably established.

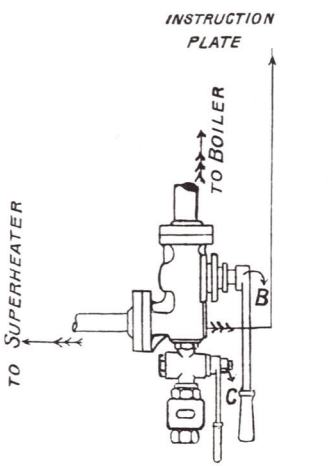
BABCOCK & WILCOX PATENT SUPERHEATERS (Integral with Boiler).

Total Heating Surface of Boiler.		Superheating by 100° to 120° F. (55° to 67° C.)			Superheating by 160° F. (90° C.)			Superheating by 200° F. (110° C.)			Superheating by 250° F. (140° C.)			Superheating by 300° F. (167° C.)		
		Code Word.	Weight of Superheater complete (approx.).		Code Word.	Weight of Superheater complete (approx.).		Code Word.	Weight of Superheater complete (approx.).		Code Word.	Weight of Superheater complete (approx.).		Code Word.	Weight of Superheater complete (approx.).	
Square Feet.	Square Metres.		Cwts.	Kilos.		Cwts.	Kilos.		Cwts.	Kilos.		Cwts.	Kilos.		Cwts.	Kilos.
735	68	Cedapreal	25	1,270	Cedapebra	27	1,371	Cedapivrol	28	1,422	Cedapoade	30	1,524	Cedapuno	32	1,625
870	81	Cedapelu	28	1,422	Cedapecri	29	1,473	Cedapidelo	30	1,524	Cedapolix	32	1,625	Cedapudio	40	2,032
983	91	Cedabrun	28	1,422	Cedapedla	30	1,524	Cedapira	32	1,625	Cedapobro	40	2,032	Cedaputres	40	2,032
1,098	102	Cedapebo	28	1,422	Cedapeepo	32	1,625	Cedapibla	32	1,625	Cedapomos	40	2,032	Cedapucuat	43	2,184
1,218	113	Cedapling	30	1,524	Cedapefix	34	1,727	Cedapibroc	32	1,625	Cedaponad	43	2,184	Cedapucino	46	2,336
1,265	117	Cedaphet	33	1,676	Cedapegrum	34	1,727	Cedapigeka	40	2,032	Cedapoda	43	2,184	Cedapuseis	46	2,336
1,411	131	Cedaringo	33	1,676	Cedapehac	40	2,032	Cedapihbo	42	2,133	Cedapoesta	46	2,336	Cedapusien	50	2,540
1,426	132	Cedapribo	33	1,676	Cedapeilla	40	2,032	Cedapimal	42	2,133	Cedaposomo	46	2,336	Cedapuocho	50	2,540
1,619	150	Cedadam	37	1,879	Cedapejri	41	2,082	Cedapijuri	43	2,184	Cedapoquel	50	2,540	Cedapunevo	62	3,149
1,741	162	Cedapacab	50	2,545	Cedapekido	54	2,743	Cedapiktha	58	2,946	Cedaposty	62	3,149	Cedapudiez	62	3,149
1,790	166	Cedapade	40	2,030	Cedapelod	43	2,184	Cedapilma	46	2,336	Cedapohan	62	3,149	Cedapuonce	66	3,352
1,827	170	Cedapaefa	41	2,080	Cedapemodo	43	2,184	Cedapim	46	2,336	Cedaposila	62	3,149	Cedapudoc	66	3,352
1,966	182	Cedapafix	54	2,750	Cedapenif	56	2,844	Cedapincin	60	3,048	Cedapodebo	62	3,149	Cedapusta	68	3,454
2,010	186	Cedapagba	42	2,130	Cedapeom	45	2,286	Cedapiolon	50	2,540	Cedapovivi	62	3,149	Cedapulla	71	3,606
2,197	204	Cedapah	54	2,750	Cedapeppa	60	3,048	Cedapipass	62	3,149	Cedapohaba	66	3,352	Cedapuma	68	3,545
2,255	209	Cedapaik	44	2,240	Cedapegic	60	3,048	Cedapiques	62	3,149	Cedapolan	71	3,606	Cedapunka	72	3,657
2,437	226	Cedapajin	58	2,950	Cedaperro	60	3,048	Cedapirik	66	3,352	Cedapono	72	3,657	Cedapuosta	77	3,911
2,531	235	Cedapakela	56	2,845	Cedapesim	60	3,048	Cedapisoto	66	3,352	Cedaposin	72	3,657	Cedapupa	77	3,911
2,690	250	Cedapalam	59	3,000	Cedapetrio	65	3,302	Cedapit	66	3,352	Cedapodia	72	3,657	Cedapugui	77	3,911
2,823	262	Cedapamox	61	3,100	Cedapeudic	65	3,302	Cedapiulod	72	3,657	Cedapoalli	77	3,911	Cedapurza	85	4,318
2,852	265	Cedapanci	61	3,100	Cedapeucli	65	3,302	Cedapiua	72	3,657	Cedapodone	77	3,911	Cedapunino	85	4,318
3,140	292	Cedapaolo	62	3,150	Cedapeudo	68	3,454	Cedapiuca	72	3,657	Cedaposilz	85	4,318	Cedaputal	91	4,623
3,240	301	Cedapapyx	66	3,360	Cedapeukig	68	3,454	Cedapiudad	72	3,657	Cedaporey	85	4,318	Cedapuvez	91	4,623
3,580	333	Cedapaquin	68	3,460	Cedapevbro	75	3,810	Cedapivot	77	3,911	Cedapotia	91	4,623	Cedapuzeca	97	4,927
3,654	340	Cedapavok	71	3,600	Cedapevaco	75	3,810	Cedapivdo	77	3,911	Cedapoque	91	4,623	Cedapufi	97	4,927
4,020	374	Cedapasoon	72	3,650	Cedapewdi	80	4,064	Cedapiwej	85	4,318	Cedapose	97	4,927	Cedapusec	103	5,232
4,510	419	Cedapaxli	75	3,810	Cedapexco	85	4,318	Cedapixie	91	4,623	Cedapoheco	103	5,232	Cedapuleum	111	5,651
4,780	444	Cedapaba	80	4,064	Cedapeyton	92	4,673	Cedapig	103	5,232	Cedapoleer	107	5,448	Cedapugato	124	6,313
5,540	515	Cedapayee	97	4,927	Cedapezcci	97	4,927	Cedapizla	107	5,448	Cedapodeke	124	6,313	Cedapuchat	124	6,313

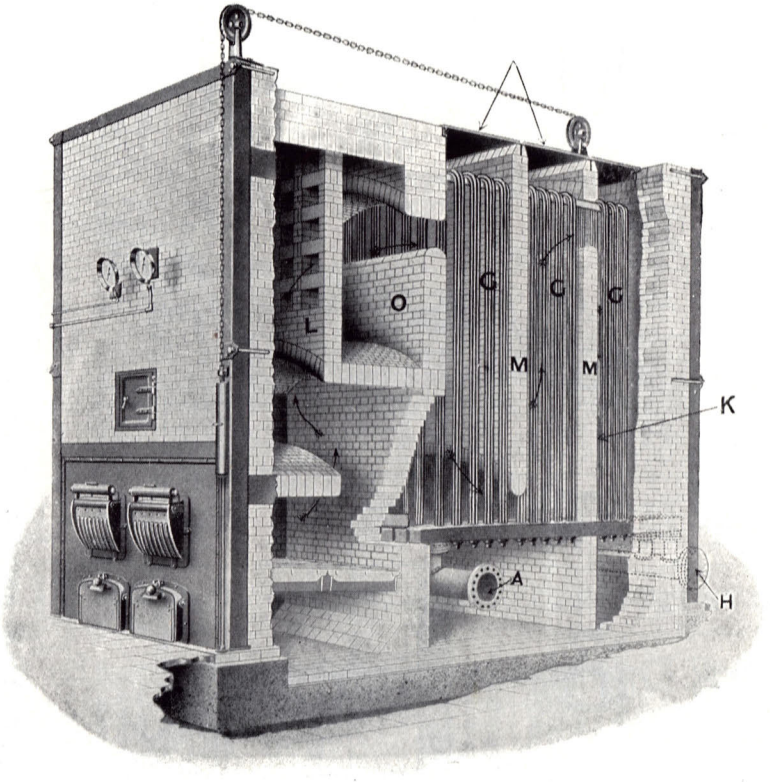
NOTE.—For larger sizes of Boilers particulars given on application.







DETAILS OF FLOOD AND DRAIN COCKS FOR INTEGRAL SUPERHEATER.



BABCOCK & WILCOX INDEPENDENTLY-FIRED SUPERHEATER.

Babcock & Wilcox Independently-Fired Superheaters.

ALTHOUGH, in the adoption of superheating, we advocate making the superheater a part of the boiler, there are certain cases in which it is necessary to use a separately-fired superheater, such as the following:—

1. Where the arrangement of the setting of the boilers and steam pipes is such as not to admit of constructing superheaters to form part of the boiler proper without stopping the works, or costly alterations in the steam pipes.

2. Where it is desired for some particular purpose to superheat steam passed through an engine that has been exhausted at a pressure of 50 to 60 lbs., such as, for instance, in Sugar Refineries.

3. For testing engines, etc.

DESCRIPTION.

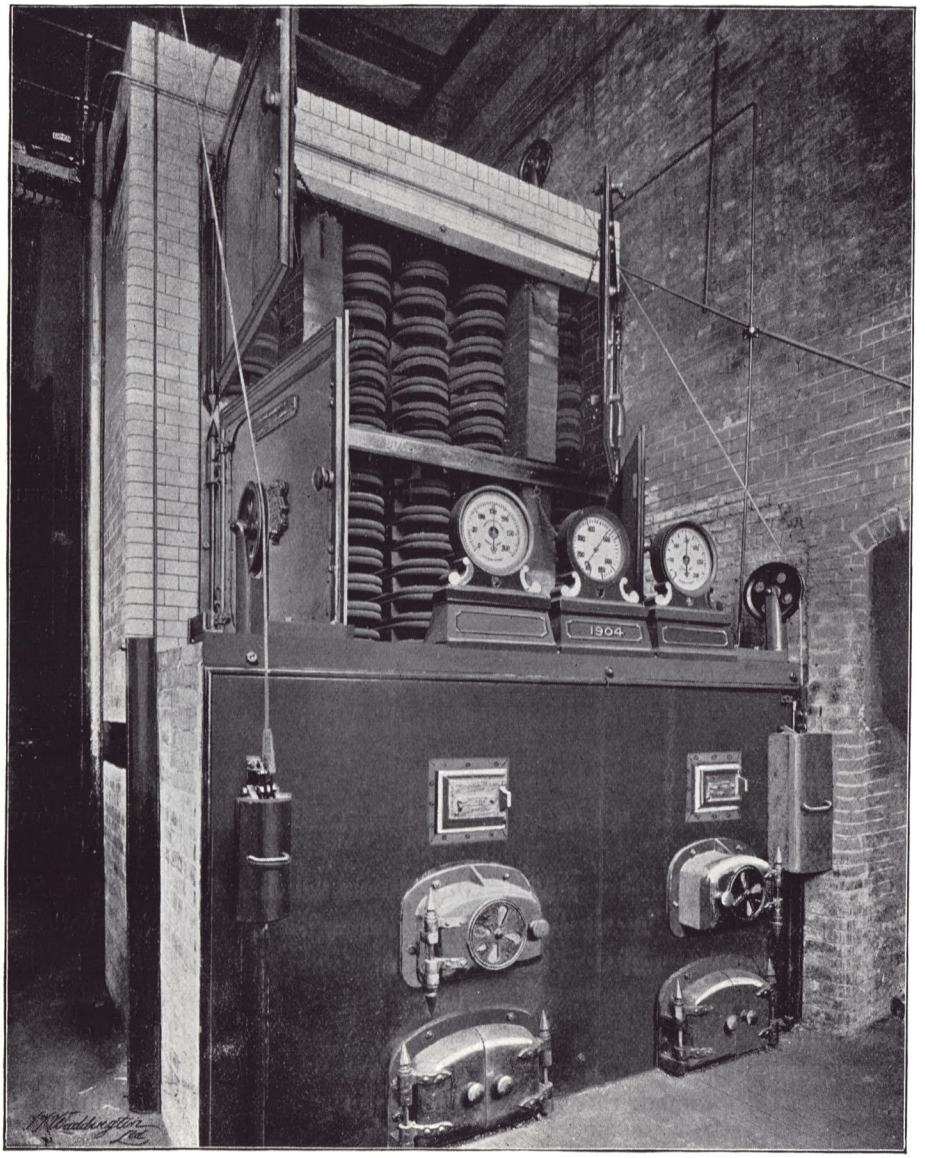
The Babcock & Wilcox Patent Independently-fired Superheater has a heating surface consisting entirely of vertical seamless tubes of $1\frac{1}{2}$ inch outside diameter, the thickness of which has been chosen specially heavy, viz., 9 gauge.

The superheater has no screwed connections, which usually suffer under the stress of expansion, but all the tubes are expanded and bell-mouthed into holes drilled in the wrought steel collectors.

The steam enters the main connecting pipe **(A)**, and thence is distributed into the horizontal manifolds which connect with it. These manifolds are inter-connected by tubes **(G)** in such a manner that a thorough circulation of the steam is obtained, the steam being eventually collected again in the collecting pipe **(H)**.

The gases pass through a perforated wall **(L)** into a muffling chamber **(O)** by which means an equal temperature can be obtained, whence they pass into the superheater chamber proper.

After having passed through the superheater tube chamber, round the brick flame baffles **(M)**, the gases pass through the damper **(K)** into the main flue.



BOROUGH OF HAMPSTEAD ELECTRICITY WORKS, LONDON.

Babcock & Wilcox Independently-Fired Superheater of 2,836 sq. feet heating surface.
Two additional Independently-Fired Superheaters also installed.

The tubes can be easily replaced, as there are handhole fittings arranged opposite each tube end for access to them; and, they can be withdrawn through the door at the top of the superheater.

All the tubes have the same dimensions, and therefore only a few reserve tubes are required.

The furnace is an ordinary grate in a closed furnace, and, in order to avoid the direct impingement of the flames on the tubes, the furnace is practically constructed as a gas furnace.

The superheater is fitted with a safety valve, pressure gauge, dial thermometer, and a drain valve to drain any condensed water that may have collected during stoppage of the superheater.

The Babcock & Wilcox Patent Independently-fired Superheater has considerable advantages when compared with others, inasmuch as no cast iron whatever is used in its construction, and there are no ribs on the tubes upon which dust and ashes can settle.

The areas for the passage of the steam are sufficiently large to avoid undue drop in pressure.

By reason of the fact that the furnace is constructed as a gas furnace, a muffled, even heat surrounds the superheater tubes, which is essential for their durability.

Designs and Estimates for Independently-Fired Superheaters are prepared on application and receipt of particulars.

BABCOCK & WILCOX PATENT INDEPENDENTLY-FIRED SUPERHEATERS.

HEATING SURFACE.		CODE WORDS.	QUANTITY OF STEAM PER HOUR TO BE SUPERHEATED									
			SUPERHEAT, 120° F. = 67° C.		SUPERHEAT, 150° F. = 83° C.		SUPERHEAT, 200° F. = 110° C.		SUPERHEAT, 250° F. = 140° C.		SUPERHEAT, 300° F. = 167° C.	
Square Feet.	Square Metres.		Lbs.	Kilos.	Lbs.	Kilos.	Lbs.	Kilos.	Lbs.	Kilos.	Lbs.	Kilos.
200	18	Cedainbad	5,060	2,300	4,300	1,960	3,500	1,580	2,900	1,310	2,450	1,120
282	26	Cedaincig	7,100	3,200	6,100	2,770	4,900	1,850	4,100	1,850	3,500	1,570
355	33	Cedaindof	9,000	4,100	7,150	3,480	6,200	2,340	5,150	2,343	4,400	2,000
452	42	Cedainfuh	11,400	5,200	9,750	4,400	7,900	2,980	6,550	2,980	5,600	2,550
570	53	Cedaingel	14,400	6,550	12,300	5,600	10,000	3,750	8,250	3,760	7,000	3,200
710	66	Cedainhab	18,000	8,160	15,300	6,960	12,400	5,600	10,300	4,180	8,800	4,000
855	79	Cedainjed	21,600	9,800	18,400	8,400	15,000	6,800	12,400	5,640	10,550	4,800
1,110	103	Cedainpart	28,000	12,750	23,900	10,900	19,400	7,300	16,100	7,300	13,700	6,250
1,330	123	Cedainqua	33,600	15,300	28,700	13,000	23,200	8,750	19,250	8,750	16,400	7,500
1,440	134	Cedainrak	36,400	16,550	31,000	14,100	25,100	9,500	20,800	9,500	17,800	8,100
1,660	154	Cedainselt	42,000	19,100	35,800	16,300	29,900	10,900	24,000	10,900	20,500	9,300
1,830	170	Cedaintur	46,300	21,000	39,500	18,000	32,000	12,000	26,500	12,000	22,600	10,300
2,000	185	Cedainvom	50,600	23,000	43,200	19,600	35,000	13,150	29,000	13,100	24,700	11,200
2,160	202	Cedainwap	54,600	24,800	46,600	21,200	37,700	14,200	31,200	14,200	26,700	12,100
2,330	216	Cedainxor	59,000	26,800	50,200	22,800	40,600	18,350	33,700	15,350	28,800	13,100
2,885	268	Cedaindam	—	—	62,000	38,300	50,400	19,000	41,700	19,000	35,600	16,200
3,600	334	Cedainbil	—	—	—	—	63,000	23,700	52,000	23,700	44,500	20,100
3,880	360	Cedainkat	—	—	—	—	—	—	56,000	25,600	48,000	21,800
4,660	432	Cedainlan	—	—	—	—	—	—	—	—	57,500	26,200

TABLE OF WORKING PRESSURES WITH CORRESPONDING TEMPERATURES.

Working Pressure in lbs. per square inch	120	150	160	200	250
Temperatures of Saturated Steam in Degrees F. ...	350	366	370	388	406

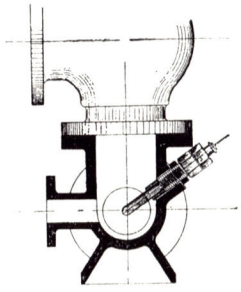
BABCOCK & WILCOX PATENT INDEPENDENTLY-FIRED SUPERHEATERS—*continued.*

HEATING SURFACE.		DETAILS.									BRICKWORK Approximate.	
		Floor Space occupied, including Brickwork.						Height to top of Brickwork.			Approx. Weight of Superheater.			
		Long.			Wide.						Gross.		Ordinary Bricks.	Fire Bricks.
Square Feet.	Square Metres.	Ft.	Ins.	m/m	Ft.	Ins.	m/m	Ft.	Ins.	m/m	Cwts.	Kilos.	No.	No.
200	18	12	10	3,910	4	5	1,345	11	6	3,505	85	4,300	5,800	2,750
282	26	15	0	4,570	4	5	1,345	12	6	3,810	100	4,910	7,100	3,300
355	33	16	0	4,875	4	5	1,345	14	10	4,520	110	5,600	8,900	4,200
452	42	14	2	4,315	6	2	1,880	12	6	3,810	130	6,600	8,300	4,100
570	53	14	8	4,470	6	2	1,880	14	10	4,520	140	7,100	9,600	4,900
710	66	16	10	5,130	6	2	1,880	14	10	4,520	145	8,000	11,800	5,500
855	79	18	6	5,638	6	2	1,880	14	10	4,520	175	8,900	12,100	6,000
1,110	103	16	0	4,875	7	6	2,285	16	0	4,875	220	11,200	12,300	6,900
1,330	123	18	2	5,535	7	6	2,285	16	0	4,875	254	12,900	12,500	7,800
1,440	134	19	3	5,865	7	6	2,285	16	0	4,875	270	13,700	12,700	8,000
1,660	154	16	0	4,875	9	9	2,970	16	0	4,875	305	15,500	12,300	8,800
1,830	170	17	7	5,360	9	9	2,970	16	0	4,875	320	16,300	13,300	9,300
2,000	185	18	2	5,535	9	9	2,970	16	0	4,875	340	17,300	13,500	9,500
2,160	202	19	9	6,020	9	9	2,970	16	0	4,875	356	18,060	14,500	10,000
2,330	216	20	4	6,200	9	9	2,970	16	0	4,875	370	18,900	14,800	10,200
2,885	268	20	7	6,275	12	0	3,655	16	0	4,875	490	24,600	15,900	13,900
3,600	334	20	7	6,275	14	3	4,345	16	0	4,875	565	28,800	17,000	17,300
3,880	360	21	2	6,450	14	3	4,345	16	0	4,875	620	31,600	17,500	17,500
4,660	432	18	8	5,690	18	9	5,715	16	0	4,875	740	37,700	18,800	19,000

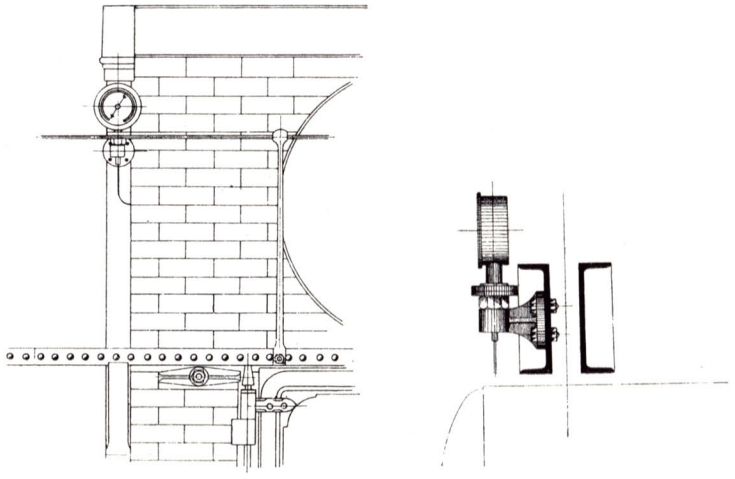
TABLE OF WORKING PRESSURES, WITH CORRESPONDING TEMPERATURES—*continued.*

Working Pressure in Atmospheres	8	10	11	14	17
Temperature of Saturated Steam in Degrees C.	174	183	187	197	206

Steel Mercury Thermometers.



METHOD OF FIXING CONTAINER END.



METHODS OF FIXING GAUGE ON BOILER FRONT.

THE steel mercury thermometer will indicate the temperature accurately at any distance up to 50 yards from the source of heat. It consists of a container, which is connected by a steel tube of a very fine bore to a hollow spring, the whole being filled with mercury. When, owing to a rise in temperature, the mercury in the container expands, it forces the surplus volume through the steel wire and thus tends to uncoil the spring, which connects to the pointer of the apparatus.

As the mercury is hermetically sealed in its steel envelope and is always under pressure, it can be heated far beyond its boiling point. Steel Mercury Thermometers are reliable for measuring temperatures up to 950° Fahr., the point at which the rigidity of the steel of the container would be endangered.

The application of these thermometers to a Babcock & Wilcox boiler, fitted with superheater, is shown by the accompanying illustrations, and in fixing them the following instructions should be followed :—Care should be taken to insure that the capillary wire is not damaged, due to being kinked or sharply bent ; a special sleeve is provided with the container, which allows it to be fixed without screwing round the whole apparatus. The sleeve should be detached from the container and screwed into the opening provided for it ; the container end should then be inserted in the sleeve, and the sleeve screwed back on to the container, which, during this operation, is held in position by means of a spanner. The lock-nut is then screwed down, thus fixing the whole apparatus ; grummet and a little red lead should be used to form a steam-tight joint.

The thermometer comprising gauge, with 6-in. dial, container, and 26 feet of capillary tube and bracket for attaching gauge to boiler front, Code word " Cebemora."

Useful Information regarding Superheat.

THE following information regarding the laws and values of the specific heat of superheated steam at constant pressure and varying temperatures, which has been collated from the most recent and reliable investigations, will be found, we think, both interesting and useful.

In Diagram A the curves from 0 to 114 lbs. per square inch have been determined by actual experiment, and the curves above 114 lbs. per square inch by extrapolation from the curves for the lower pressures. These curves were published in the "Zeitschrift des Vereines Deutscher Ingenieure" of the 19th and 26th January, 1907, and have been drawn out with the object of helping practical engineers in their calculations. From these tables it will be seen that the specific heat of steam is a maximum at saturation point at all pressures above atmospheric, and decreases until it reaches a minimum, which takes place at a higher temperature. After reaching the minimum the specific heat rises with an increase of temperature.

Basing on the curves of Diagram A, the more important mean specific heats have been determined by means of planimetring between the saturation temperatures t_s, and steam of various final temperatures t, the results are combined into curves on Diagram B, so that the mean specific heat from saturation temperature to any given temperature can be easily ascertained.

For instance, assume we require to determine the heat necessary to superheat steam of 170 lbs. per square inch absolute pressure to 572° F. The mean specific heat at this temperature and pressure from Diagram B is 0·541 ; the temperature of saturated steam of 170 lbs. absolute pressure is 368° F. ; consequently, the degree of superheat required is 204° F., and the total heat required for this degree of superheat per lb. of perfectly dry steam at 170 lbs. per square inch absolute pressure is $204 \times 0{\cdot}541 = 110{\cdot}4$ B T U's.

Steam leaving a boiler, however, is never absolutely dry, so that to the above-mentioned figure must be added the heat necessary to evaporate the entrained moisture. The heat of vaporisation or latent heat of steam at 170 lbs. per square inch absolute pressure is 853·8 B T U's. per lb., therefore, for each degree of moisture entrained $0{\cdot}01 \times 853{\cdot}8 = 8{\cdot}538$ B T U's. must be added to the 110·4 B T U's. required for superheating.

The specific heat of 0·541 is the mean value for all specific heats between that of the saturation temperature (specific heat = 0·66) and the final temperature of 572° F. (specific heat = 0·50, see Diagram A).

DIAGRAM A.

CURVES OF SPECIFIC HEAT AT VARIOUS TEMPERATURES AND PRESSURES.

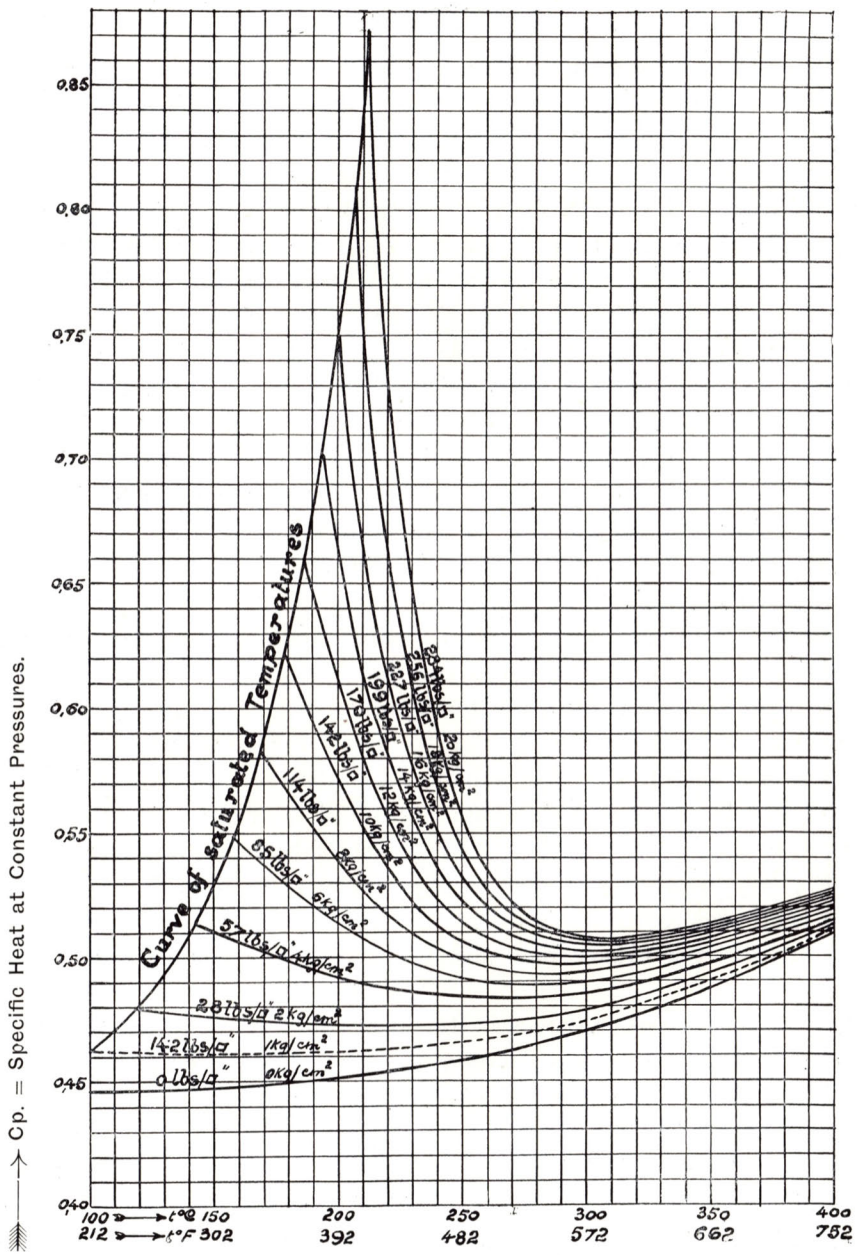
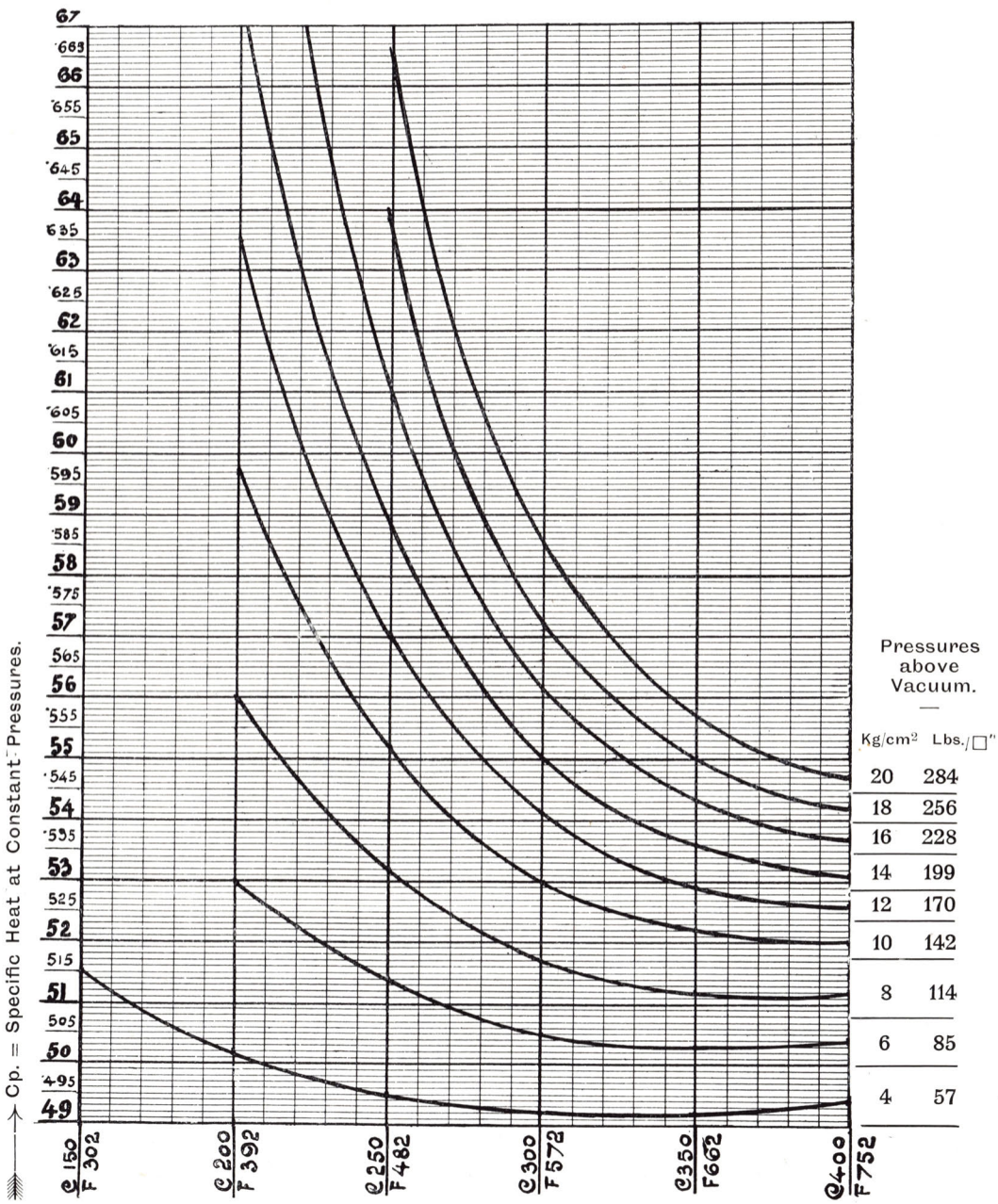


DIAGRAM B.

CURVES OF MEAN SPECIFIC HEAT AT VARIOUS TEMPERATURES AND PRESSURES

BASED UPON THE CURVES IN DIAGRAM A.



Equivalent Evaporation from and at 212° F. of Saturated and Superheated Steam, at various steam pressures and temperatures of Feed Water.

The diagram of equivalent evaporations, on opposite page, is read in the following manner:—

For Saturated Steam, use only the right-hand side of the diagram.

The equivalent evaporation from and at 212° F. is found by taking the point of intersection of the vertical line representing the steam pressure with the curve representing the feed temperature, and following a horizontal line to the **right-hand** side column, where the factor is read off.

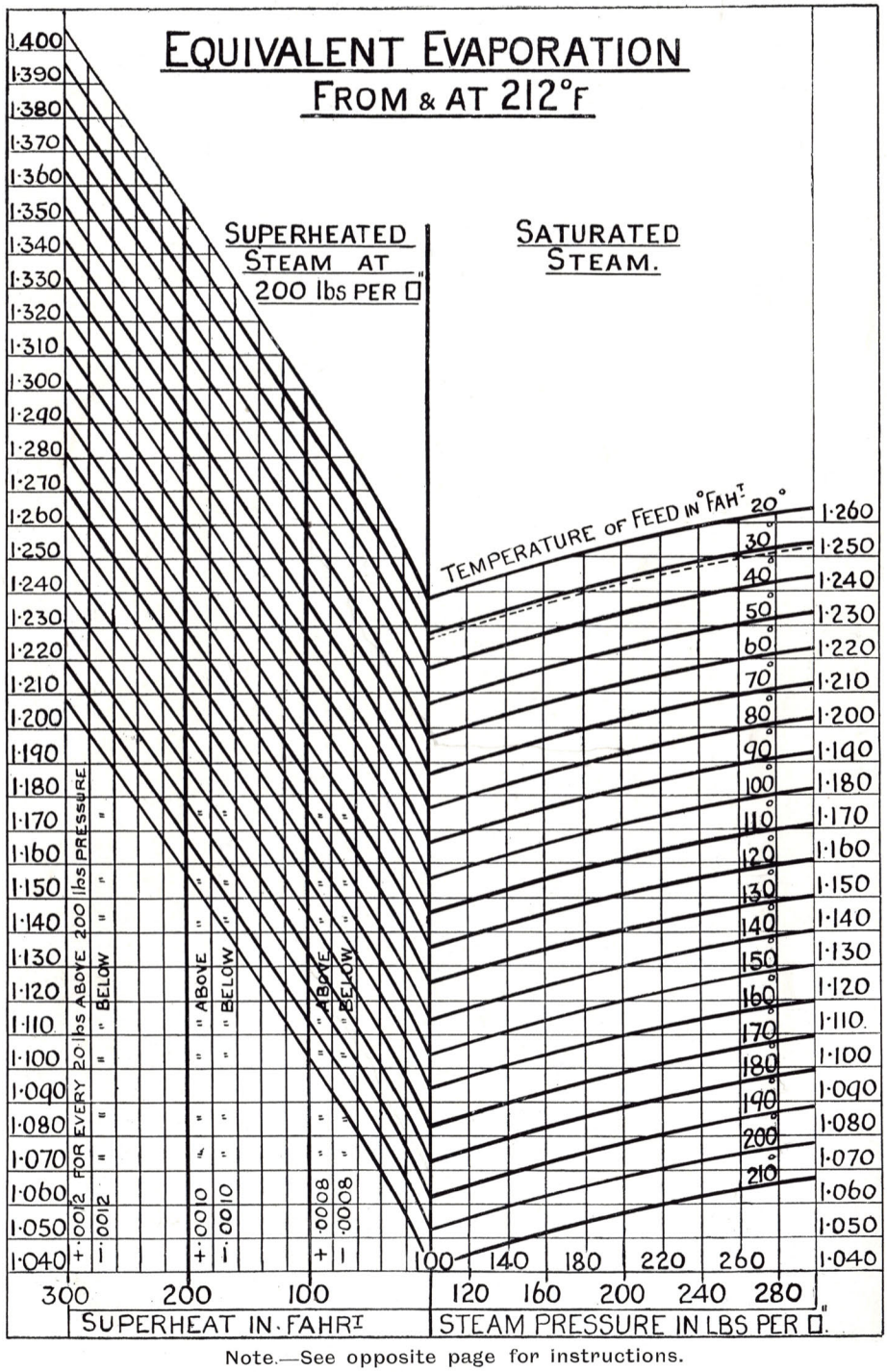
Thus, if the steam pressure were 200 lbs. and the feed temperature 150° F., the factor of evaporation would be 1·120.

For Superheated Steam, both sides of the diagram are used.

Find on the right-hand side of the diagram the point of intersection of the vertical line representing the steam pressure with the curve representing the feed temperature and follow a horizontal line to the left up to the dividing line between the two diagrams; then follow the nearest curve until the vertical line representing the degree of superheat is intersected, when the corresponding factor of equivalent evaporation will be found by following a horizontal line to the extreme left-hand side of the diagram.

Taking the case of water at 70° F. evaporated into steam at 180 lbs. pressure, superheated by 100° F., it will be found that the vertical line representing 180 lbs. steam pressure intersects the curve for 70° F. feed temperature on the saturated steam factor line 1·200. Follow this line to the left till it reaches the vertical dividing line between the two diagrams, then follow the nearest curved line until the vertical line representing 100° of superheat is reached, the point of intersection will be found to be on the line marked 1·260, which is the equivalent evaporation required.

Since, in the case of superheated steam, the specific heat varies with the pressure, a correction is given on the left-hand side of the diagram for every 20 lbs. pressure over or under 200 lbs. per sq. inch, for superheats of 100°, 200° and 300° F.



Note.—See opposite page for instructions.